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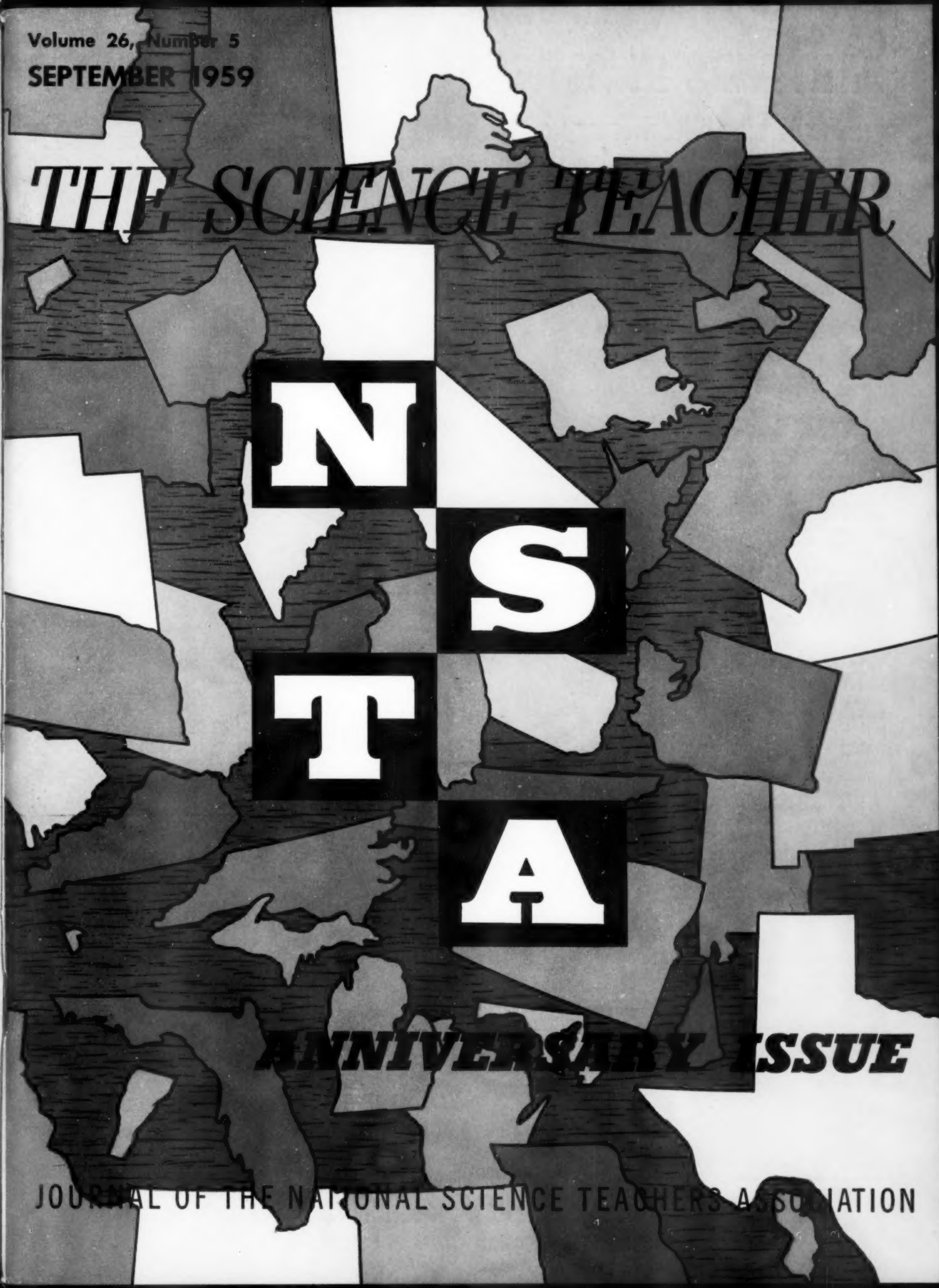
THE SCIENCE TEACHER



ANNIVERSARY ISSUE

JOURNAL OF THE NATIONAL SCIENCE TEACHERS ASSOCIATION

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On the Fifteenth Anniversary of the National Science Teachers Association, we of the Business-Industry Section pledge our continued cooperation in providing America's schools with educationally-approved services and materials.

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Yale & Towne Manufacturing Company
Youngstown Sheet & Tube Company

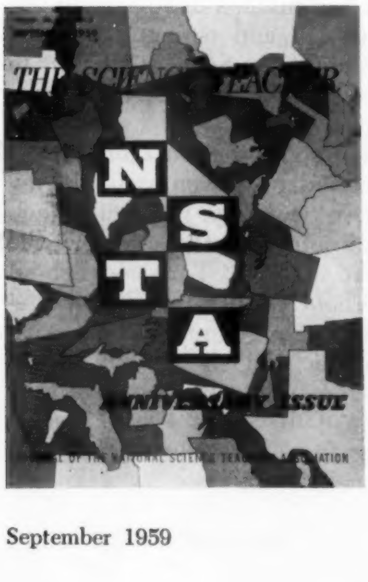
BUSINESS-INDUSTRY SECTION, NATIONAL SCIENCE TEACHERS ASSOCIATION

READ THE HISTORY OF B. I. ON PAGE 304

NATIONAL SCIENCE TEACHERS ASSOCIATION
MEMBERSHIP BY STATES
May 31, 1959

STATE	NUMBER OF MEMBERS 1958	1959	RANK BY POPULATION 1950	RANK BY MEMBERSHIP 1958	1959
Alabama	95	124	17	30	28
Alaska	15	17	45	51	51
Arizona	94	103	38	31	30
Arkansas	73	73	30	36	35
California	900	1103	2	2	2
Colorado	213	209	34	13	18
Connecticut	195	245	28	16	14
Delaware	46	54	48	43	42
D. C.	150	157	36	23	24
Florida	184	254	20	18	13
Georgia	131	155	13	26	26
Hawaii	81	90	51	32	32
Idaho	18	17	44	49	51
Illinois	465	557	4	5	5
Indiana	233	259	12	12	11
Iowa	182	227	22	19	16
Kansas	134	191	31	25	23
Kentucky	75	89	19	35	33
Louisiana	127	122	21	27	29
Maine	47	51	35	41	43
Maryland	240	258	24	10	12
Massachusetts	276	342	9	9	9
Michigan	327	479	7	8	6
Minnesota	256	286	18	11	10
Mississippi	155	59	26	22	41
Missouri	146	207	11	24	21

STATE	NUMBER OF MEMBERS 1958	1959	RANK BY POPULATION 1950	RANK BY MEMBERSHIP 1958	1959
Montana	50	65	43	39	38
Nebraska	77	91	33	34	31
Nevada	11	24	50	52	49
New Hampshire	40	41	46	44	47
New Jersey	353	422	8	7	8
New Mexico	47	48	40	41	44
New York	1077	1312	1	1	1
North Carolina	126	157	10	28	24
North Dakota	55	62	42	38	40
Ohio	575	655	5	4	4
Oklahoma	204	209	25	14	18
Oregon	160	193	32	21	22
Pennsylvania	652	797	3	3	3
Puerto Rico	18	21	52	49	50
Rhode Island	40	44	37	44	45
South Carolina	39	65	27	46	38
South Dakota	50	71	41	39	36
Tennessee	78	144	16	33	27
Texas	409	432	6	6	7
Utah	57	68	39	37	37
Vermont	26	44	47	48	45
Virginia	187	214	15	17	17
Washington	202	237	23	15	15
West Virginia	97	86	29	29	34
Wisconsin	168	209	14	20	18
Wyoming	34	36	49	47	48
TOTAL	9938	11,722			



THIS MONTH'S COVER . . .

In the gala spirit of our 15th Anniversary, the States are portrayed in a burst of excitement and activity dislodging them from their normal geographic locations. With an increase of 18 per cent in membership over last year, and the mounting interest of science teachers to become a part of our Association, we challenge you—state by state—to keep this spirit alive and compete for improved positioning of your state presented in the report above.

ROBERT H. CARLETON has served as Executive Secretary of the National Science Teachers Association since September 1, 1948. Born in Dayton, Ohio, he received the BS in Education Degree from The Ohio State University with a major in chemistry and minors in biology and physics. He holds the MA Degree from New York University and has done other advanced work at Michigan State University. His teaching experience in high schools and colleges extended over a period of twenty years. In addition to the writing of several textbooks in high school science, he has written for various educational journals.

THIS ANNIVERSARY ISSUE of *The Science Teacher*, commemorating fifteen years of service, July 4, 1944 to July 4, 1959, was prepared for a two-fold purpose:

1. To roll back the years and relate in documented form the history of our Association from its earliest beginnings; and
2. To reel out the goals and objectives of the Association geared to meet the needs of an ever-changing world in future years.

The story of NSTA, prepared for the first time, acquires full meaning only as it relates to the efforts and endeavors of the membership, and those cooperating groups and organizations who have contributed so zealously to its progress during the years.

As the chronology unfolds, it is hoped that you will be able to capture the spirit in which our Association works. Fundamentally a service organization devoted to the development and improvement of science teaching and to the enrichment and growth of our science teachers, the Association has realized a tremendous growth and exercises an effective influence for progress in the many areas of science education.

We welcome this opportunity to report on the activities of NSTA and to outline the hopes and goals of our officers, directors, and members. The outlook for continued growth and expansion in the age ahead represents a challenge for each one of us, and our associates.

We invite you to resurge with us in the era of the future, and rededicate yourselves to greater achievements in the traditionally professional and cooperative attitudes so characteristic of our members-at-large.

We encourage those of you who will be reading the story of our Association for the first time through the complimentary distribution of this Anniversary issue to examine the record, to reflect on the portent of the future in science education, and to avail yourselves of the opportunity to serve and to be served through membership in NSTA, your professional society.

To those contributing members, authors, the staff, and organizations and societies joining us in this event, we express our earnest appreciation. Equally important has been the cooperation and enthusiastic endorsement of our advertising clients, without whose support this publication project would not have been possible. Their participation has enabled us to expand our normal 64 pages to 112 and to name-mail the September 1959 issue of *The Science Teacher* to 40,000 recipients. This is about 23,000 over our regular mailing.

Having been involved in the work of the Association over a period of eleven years in my capacity as Executive Secretary, it is with much personal pride and affection that I view the historical record here set forth. The years behind have not been without hurdles or discouragement, but from obscure beginnings we have emerged into a dynamic progressive body. Thus, with the record before us, your Executive Secretary and staff join with you in a rededication for greater progress in all segments of Association life for the benefit of all.

THE SCIENCE TEACHER

The National Science Teachers Association is a department of the National Education Association and an affiliate of the American Association for the Advancement of Science. Established in 1895 as the NEA Department of Science Instruction and later expanded as the American Council of Science Teachers, it merged with the American Science Teachers Association and reorganized in 1944 to form the present Association.

Volume 26, Number 5 — September 1959

ANNIVERSARY SECTION

SEPTEMBER ISSUE

Readers' Column

School Financing

Recognizing that the school finance situation is quite bleak in many states, I can certainly understand that local school boards would clutch at make-shift operations such as that described in the *Reader's Digest* reprint sent to us through the NSTA packet service by the Berg Foundation. At first glance, this seems a worthy thing for NSTA to promote.

While many aid-to-education programs have real merit, we must constantly be alert to avoid becoming unwitting pawns in a far-reaching campaign to prevent the American schools from operating on a solid financial footing, supported by all the people through an equitable tax structure. The hope that we can achieve fundamental and lasting improvements in schools by soliciting sporadic voluntary handouts from business, industry, scientists, retired military personnel, etc., is a tragic delusion. The real moral of the *Reader's Digest* story is that the American people, understandably motivated by the short-range desire to save money and misled by subtle "save the poor taxpayer" articles of this type, have sought "gimmicks" instead of facing the underlying needs of our educational system.

All too often, the very groups so eager for "cooperation" on the local level are leading the fight against the kind of tax structure which would support adequately paid, well trained teachers which students really need. NSTA, along with other educational groups, must make one thing clear: the schools are in trouble, and they need massive, continuing support from all segments of the American economy. It is hypocrisy for NSTA to accept handouts from the very people who oppose this kind of support.

A case in point is the present condition in the state of Michigan. It is evident to the science teacher in this state that it will take more than free pamphlets and visits from industrial engineers to improve science education in our schools. But every move to put the state's school finances on an even keel has been met by the cry, "Higher taxes will drive industry out of the state!" This protest from Harlow Curtice, former president of General Motors, was published in the *Detroit News* the very same week that another General Motors executive was quoted as complaining that our schools were doing an inadequate job of training scientists and engineers.

Certainly we must not go out of our way to antagonize any important group in our society, but we should look carefully at the motives of any group

THE SCIENCE TEACHER

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Articles published in THE SCIENCE TEACHER are the expressions of the writers. They do not represent the policy of the Association or the Magazine Advisory Board.

MEMBERSHIP

The membership year coincides with the calendar year. New entries during the fall months extend through the following calendar year.

Regular Membership	$ 6.00
Sustaining Membership*	10.00
Student (college and university) Membership	2.00
Life Membership* Payable in ten annual installments; $150.00 if paid in three years or less.	175.00
Library Subscription*	8.00

*** Includes the *Elementary School Science Bulletin*.**

which seek to conceal or bypass the real needs of our schools. These needs call for careful analysis and thorough review for long-range plans.

GERALD M. REES
1212 Franklin Blvd.
Ann Arbor, Michigan

Semantics

Just as L. W. Phillips[1] finds "aberrations" in the "inferences drawn from textbook statements" in physics, so teachers of chemistry find reason to examine their books. Those books also have phrasing of such long standing that it may seem a bit presumptuous to question their semantics.

One such is the so-called Periodic Law. An inventory of a score or more high school and college books for general chemistry discloses that over fifty per cent copy Mendeleev's original phrasing. The majority of the more recent texts use "atomic numbers" in place of "atomic weights" in the statement, "The properties of elements are periodic functions of their atomic weights." A very few use the word "recurring" in place of "periodic," but rare indeed is the author that tampers with the word "function." Those concerned over the phrasing are critical of the two words "periodic" and "function." As one author[2] puts it, "periodic functions are those that return to their maximum values after *equal* intervals." The use of the word "recurring" by the few authors, previously mentioned, may indicate that same concern.

The word "function" is, presumably, used in the law to have a mathematical meaning. In that setting, dictionaries define it as "a magnitude so related to another magnitude that to values of the latter there are corresponding values of the former." The simplest such relationship would have magnitude A equal magnitude B modified by a third factor usually a constant. The chemist queries, "Could such a relationship be set up for relating properties of elements to their atomic numbers?" If not, then such a statement is quite lacking in operational utility. It is wasted words for the student. If a formal statement is required, why not a descriptive one such as, "When the elements are arranged in the order of increasing atomic number, elements of similar properties occur at regular intervals?" This tells how one arrives at the relationship and does not do violence to the student's mathematical vocabulary.

B. CLIFFORD HENDRICKS
Lower Columbia Junior College
Longview, Washington

[1] L. W. Phillips. "Aberrations in Discussions of Newton's Laws." *The Science Teacher*, 26:16.

[2] H. G. Deming. *Introduction to College Chemistry*. John Wiley & Sons, New York.

Editor's Column

"To everything there is a reason . . .
And a time to every purpose under the heaven . . ."
ECCLESIATES

APC*

Each president of NSTA has probably asked himself, what is the most important service I can perform for the organization? The answers of the presidents have been characterized by individuality and variety as shown in the record. Their efforts and contributions have been presented at many meetings such as the colorful array of ideas, events, and actions of the past presidents so ably conveyed at the last convention in Atlantic City. This was a spectacular summary of the creation of desirable mutations in each official "year child" of NSTA, resulting from the wedding of ideas of presidents and actions of members. Brief accounts of the various contributions made, and the pictures of all the presidents in a display corner at the national office of the Association would serve as an inspiration to those who would stop to look at the faces, read the names, ponder the dates, and reflect on the ideas and events that have enabled the Association to grow and through them—become what it is today. This would also be an intelligent guide to future presidents as they contemplate the services they might perform for NSTA. This is the moment of my final contemplation. This is the "count down," when ideas held in the pollen-grain stage must thrust themselves toward the womb of perpetual energy, held in readiness by the members of the Association. This is the time for the fertilization of ideas between a president and each member, if the gestation period is to have its full term and birth of action is to occur at our National Convention. The curtain is lowering on the first act of the 1960-1961 drama of NSTA. The initial "APC" must end and the stage must be set for the second act, titled "APS."

APS*

To be effective, services and ideas must reflect the dynamics of the total cultural period in which they take place and operate. They must lend themselves to refraction as they pass through the mediums of former practice, present aims, and future goals, for each medium has its own density and bends ideas and services without regard to their originator.

Services and ideas must capture the leaf-budding spirit of change at the time of its conception and urge the unfolding and growth of each bud and twig so that the entire Association matures the ideas to actions and each member becomes as a "leaf and environment interacting," producing the starch of action that makes an organization firm and the sugar of modification by which it feeds itself and sustains and extends its life.

Contemplation of the ideas expressed has yielded an analysis of science education in this present cultural period and has been responsible for the following suggestion. Emotionally and intellectually, teachers and administrators are ready to plan a series of cumulative, well

organized educational experiences for students during their twelve to thirteen years of formal education. They are willing to consider seriously the modification of the present three distinct and often unrelated, repetitious or duplicated educational programs of the kindergarten through sixth grades, the seventh through ninth grades, and the tenth through twelfth grades. They seek advice and directives that will guide their curriculum modification efforts toward a K-12 program characterized by a series of related yet distinct experiences that guarantees a curriculum distinguished by quality rather than quantity.

If all the science that is known could be taught to all students in the schools in twelve or thirteen years, quantity and quality would mutually characterize the science curriculum. We make a great effort to achieve this goal, and in consequence the curriculum guides become thicker, the textbooks become heavier, the teachers pester the administration for more time, the students spend more hours in classes, and the teaching units of dedicated teachers are constructed at each grade level as though this were the only opportunity students would ever have to learn science. Had this plan operated in the transference of chromosomes, we would have been compelled to seek other planets to accommodate a population of living things characterized by more bulk than planet Earth can support. We are at the period of development in ideas when schools cannot support all of them without increasing the school day, which has been suggested. This method leads up a blind street, for a day has limits also and in the long future course of events, the school day has a terminal point at which another day begins and unless the size of the orbit of the earth can be increased, we will eventually be compelled to be selective in the number of ideas we attempt to teach. Selectivity now is a more practical route to adopt than lengthening the school day, for it is a continuing solution for as long as education is an activity of man. This, then, is one objective, and perhaps the most important one, to be achieved in designing a K-12 program in science.

Each science idea that has been conceived is not of equal importance to every other science idea in the science education of youth. Some ideas are distinguished by the quality of the concept involved. Others are not distinguished because they are only one minute part of a great quantity of information that has been gathered. A science curriculum should be distinguished because it includes, at the grade level where they can be learned, selected concepts of recognized quality in science. It is further distinguished by the careful selection of the number of science experiences students need to have to develop these quality concepts. For example, we cannot teach all that has been known and is known about nuclear energy. The responsibility of the K-12 program planner is to select the quality concepts and experiences for each grade level so that a student continually enriches his knowledge and understanding of nuclear energy with additional concepts of quality and he graduates knowing that although there is much he hasn't learned, he has a good foundation upon which to build his future education. This selectivity we owe our science students as their natural heritage from a professional organization.

This readiness for basic improvement and the current exploration for help almost demands that NSTA set itself the task of answering these questions:

1. What are the criteria one can use to evaluate a K-12 science program?
2. What are some desirable K-12 science programs that can be used as examples?
3. What principles of a K-12 science program does the NSTA accept and promote?

How and where can these questions be answered? By thinking and planning prior to our 1960 National Convention. By study, discussion, and recommendation at our Convention. By writing and publishing our report after the Convention. The challenge has been accepted by the program planning committee. The Chairman, Miss Dorothy Tryon, is uniting the efforts of the Committee so that one of the basic themes to be carried through the Convention will be the K-12 science program.

APH*

The time has arrived when NSTA as a duly constituted body of science teachers that meets once a year, should engage, at that time, in the professional activities of developing attitudinal stands on important current issues in science education. Then plans should be made to activate those beliefs through its members, its committees, its staff, and in cooperation with other groups. This would require members to rededicate themselves to Association goals which make it our privilege and responsibility to be effective contributors to basic curriculum improvement in science education.

"To everything there is a reason . . ."

Donald G. Decker

* APC—A President Contemplates
APS—A President Suggests
APH—A President Hopes

Publication of Tomorrow's Scientists

A "two for the price of one" student science publication has just been made available through the merger of NSTA's *Tomorrow's Scientists* with *Science World,* now being published by Scholastic Magazines, Inc., 33 West 42nd St., New York City.

Both of these student journals have gone through three years of successful publication and have had wide circulation to thousands of readers. Continually increasing quality of content and an accelerated subscription response are to be expected from the new editors and publisher.

The NSTA Board of Directors has authorized official Association cooperation in the revised plan in a number of ways. Winning entries in the program of Student Science Achievement Awards will continue to be published in the *Tomorrow's Scientists* section of *Science World.* Also, the Association will have representation on the *SW* Advisory Board. Appointees for 1959-60 are: Miss Anne Nesbit, South Junior High School, Pittsfield, Massachusetts; Dr. Sam S. Blanc, Gove Junior High School, Denver, Colorado; Dr. Stanley E. Williamson, Oregon State College, Corvallis, Oregon.

Sixteen issues of *SW-TS* will be published during the school year. The subscription price is $1.50; all orders should be sent to Scholastic Magazines, Inc., *not to NSTA.*

THE $\int_{1}^{\infty} f(x)\,dx$ INFINITE INTEGERS

By JAMES R. KILLIAN, JR.

Special Assistant to the President for Science and Technology, Washington, D. C.

I AM happy to join in the celebration attending the fifteenth anniversary of the establishment of the National Science Teachers Association. The Association has become an increasingly effective agency working in the interest of better science teaching in our schools and it has undertaken many important projects, carefully and thoughtfully worked out, to improve our teaching. It is appropriate to celebrate these achievements of the past fifteen years and to look forward to a growing and increasingly useful Association in the years ahead. I appreciate this chance to congratulate the Association and to comment upon the problems and opportunities of science teaching today. Finding its expression in the climate of freedom, America's formula for the ultimate attainment of our goals in science teaching is found in the people themselves—the Infinite Integers.

During the last quarter century our schools have gone through a phase during which languages, mathematics, and science have been far too generally neglected. This has occurred in part because the attitudes and values of the American people resulted in a low value being placed on these subjects. But, whatever reason, we are now engaged in a great effort to strengthen science education, and the American people are backing this effort. It is not that we want to make scientists of all our young people—far from it. Rather, it is that science courses have come to be a "poor relation" in the curricula of

many schools. Until recently we have done little —save in our best schools, where science is given its proper place and taught as well as anywhere in the world. We have been blocked by the baseless fear that if we strengthen our science education, we might run the risk of distorting the emphasis on other subjects. I hold that we have extraordinary opportunity and unique incentive now to strengthen science education, and that in doing so it can serve to strengthen other parts of the curriculum. Science can be the flagship in leading to a deepening and strengthening of the high school curriculum.

These opportunities and requirements recently led the President's Science Advisory Committee and its panel on science and engineering education to publish a statement on education entitled "Education for the Age of Science." [1] I would like to quote a section directly from the report which bears particularly upon one of the problems facing the science teacher.

The Problem of Mutual Understanding

> One of the great strengths of this nation is the diversity of its citizens. No man or council of men dictates what our people individually should do, or how they should be educated. Each of us is remarkably free to pursue that which interests or profits him personally. Out of this great diversity of individual expression comes great strength and wide capability. The diversity should be husbanded. But it cannot long be fruitful if it breaks the nation into isolated groups. Going his own way, a man must understand why other men go theirs, and must respect their right of choice.
>
> A primary objective of an improved educational system should be to bridge the gaps between important segments of the American people. There are many such gaps, even among highly educated people: between scientists and artists; between intellectuals and non-intellectuals; between the scientists, humanists, and social scientists; between scholars, research workers, and teachers; between "pure" scientists, applied scientists, and engineers; and there are others. Such gaps inhibit the close collaboration between groups which is essential to improving the intellectual atmosphere and developing a better and stronger society.
>
> We are especially concerned about the gap between the man or woman who practices a science and the man or woman who teaches it. In the high school, and to some extent even in the colleges, the teacher does not find adequate contact between himself and the professional scientist or engineer.
>
> The damage this does is manifold. It deters the scientifically-minded young man or woman from seeking to make a career in high school teaching, since he may feel that he will cut himself off from the world that interests him. It deprives the high school student of the assurance that he will be taught science by someone who understands the subject and loves it. It robs both science and engineering of bright young students who under the proper stimulus in a secondary school might have found in those subjects the promise of a satisfying career.
>
> The responsibility for an attack on this state of affairs clearly lies with the scientists and engineers themselves. They should attempt to keep the high school and college teacher in the main stream of science, and to welcome him as a member of the profession, performing functions no less vital than those of the research man, the professor, or the practicing engineer. It serves no purpose for the professional man to be critical of high school or any other teaching, unless he himself is prepared to take steps to help improve it. Indeed it is irresponsible.

"Education for the Age of Science," after examining the *inevitable* shortage of adequately prepared science teachers as both the number of students and the demands on teachers increase, concludes that we must aid those teachers we now have in every effective way. The report lists five such ways:

(1) Many of the non-teaching tasks now imposed on teachers should be assigned to others who are specially employed for the purpose;

(2) Teachers' salaries should be increased to the point where the teacher does not have to work on other jobs to eke out a living. Being properly paid for his real job, he can be expected to devote all his time to teaching and self-development and to take his rightful place in society;

(3) Time should be provided in the academic year (and pay in the summer) which will permit teachers to keep up with their subject matter; leaves of absence should be allowed for the purpose of enabling the teacher to add to an understanding of his subject matter;

(4) We should reexamine our methods of training new teachers. We need to evaluate anew the relationship between curricula devoted to the art of teaching and those devoted to the substance of what is to be taught. We need to design programs that recognize that methods and substance cannot be divorced. We almost certainly need to place a higher emphasis on substance. Teacher certification

[1] Available through the Government Printing Office, Washington 25, D. C. 20¢ a copy.

DR. JAMES R. KILLIAN, Jr., a native of South Carolina, has served as Chairman of the President's Science Advisory Committee since 1957. He is a graduate of Duke University and the Massachusetts Institute of Technology. Following his tenure of other executive positions on the staff of MIT, he became their tenth President in 1949. Dr. Killian took leave fom MIT to serve on the President's staff. Dr. Killian's experience as editor of *The Technology Review*, a member of various committees under the Executive Office of the President dealing with science and technology, and contributor to many fields of arts and science make him one of the outstanding spokesmen of our time.

generally should lay more stress on subject knowledge than it does now. We suggest that subject knowledge should be stressed not only to *become* certified but to *stay* certified, and the need to keep up-to-date should be emphasized even by reexamination, if necessary. Conversely, we deplore those rules which exclude from secondary teaching first-class scholars solely because they lack the proper number of credits in "education";

(5) Finally, and perhaps most urgently, we must devote very substantial resources to developing and supplying teachers with far more adequate and up-to-date teaching and learning aids of all types.

I would add that there is another important requirement for the improvement of science education which involves the correction of some strange notions about science. There is a widespread view, for example, that science is "vocational," that it is "materialistic," and "anti-humanistic"—that it contributes only to the practical needs and the defense, but not to the quality of our society.

Unlimited Factors

It is my own deep conviction that the liberal arts cannot be liberal without including science, and that humanism is an indispensable ally of science in a sound scientific education. In the face of the practical responsibilities which rest in science and engineering for our security and our material welfare, it is all too easy for people to conclude that science is inimical to the spiritual ends of life and for them to fail to understand that in reality it is one of man's most powerful and noble means for seeking truth, and that its driving force is the thrust of man's curiosity to discover more of the beauty and order of the universe. Scientists have an obligation to make this true character of science better understood, not by an arrogant advocacy of science and technology as the only objective means to increase our understanding and well-being, but by the balanced and tolerant presentation of science as one of the powerful means by which man can increase his knowledge and understanding and still remain humble and ennobled before the wonder and the majesty of what he does not understand. As George R. Harrison has eloquently written: "There is no evil, no inhumanity, in the primary task of science, to forward man's love and desire for truth. An increased awareness of truth has often made men uncomfortable, but seldom has it made them less human. Science increases the areas of spiritual contact between man and nature, and man and other men."

Let us not forget this complementary character of science, which deals with nature, and of the humanities which deal with man. To be most effective the scientist must study nature in a world of men and the humanist must study man in a physical environment dominated by science. Neither can achieve optimum effectiveness without working in harmony with the other and without the benefit of a harmonious and understanding reaction one with the other.

Let it also be noted that we have a far better chance of producing great scientists in America, if we have an educated community that understands science and values it, as well as the humanities, and that views them both as essential parts of our culture and the wholeness of learning.

WHAT DOES FREE SOCIETY DEMAND OF THE Scientifically Educated?

By PAUL H. DOUGLAS

United States Senate, Washington, D. C.

(Address given at Marquette University College of Engineering, May 21, 1959[1])

IT is my belief that a free society expects that its scientists and engineers will know their jobs. No amount of social consciousness can compensate for lack of expertness in the fundamental principles of mechanics, electricity, and chemistry, and in the ways in which the tremendous powers latent in nature can be most efficiently, economically, and safely employed.

Frequently, scientists and engineers, like other technicians—even in the social sciences, become impatient with the theoretical foundations of their sciences and become concerned only with their applied aspects. This is, of course, a mistake. I do not believe that a man can be a truly first-rate engineer, for example, unless he is also trained in theoretical physics and chemistry with ample laboratory work. He should recognize that success in these subjects increasingly rests on a thorough mastery of mathematics, which is absolutely as basic for applied engineering.

I believe that one educational consequence of this is that we should offer, perhaps require, more mathematics in the high schools and teach it better. To help in this work, the better students should be put on a separate track where they can do more and better work; then mathematics and science can be made part of the core for all academically able students and particularly for those who are scientifically inclined.

I would suggest, moreover, that science is a cultural as well as a rational and applied subject. Its study gives one new respect for the intellectual powers of mankind, of how physical truth must be discovered and continually sought, and of how truth is not static but unfolding. Certainly the modern discoveries of the vastness of the universe on the one hand and the amazingly complex structures of atoms and chromosomes on the other should cure any tendency toward human cockiness and lead instead to that wonder which, as Plato said, is the beginning of all philosophy.

Society has the right to expect that its experts shall be concerned with the end effects of their work and, indeed, the purpose of life itself as well as mere technicalities.

Engineers have been subject to justified criticism in the past on the ground that they have been so absorbed in construction and operation that they have paid scant attention to the purposes for which their work was being used. Leonardo da Vinci served willingly as military adviser and engineer for Caesar Borgia. Moreover, as city planner in Milan for Lodovico Sforza, he drew plans for a future city where only the aristocracy were to be allowed to live in the sunlight, while the common people were to be compelled to live and work underground. In a similar fashion, the great German engineers worked just as willingly for Hitler as they had for industry under the Weimar Republic. A lot of technical skill went into the construction of the gas chambers where six million Jews and anti-Nazis were gassed to death by Hitler.

We do not know a great deal about the Russian engineers under Communism. At times, they have been made the victims of false charges and brutal purges. But at times they seem in the main to have put their talents freely at the disposal of a merciless police state which in turn has developed and rewarded them as long as they did not question either its goals or its tactics.

Similarly, in this country we have seen talented engineers serving loyally and effectively under brutal managements without any apparent twinges of conscience. And engineers have commonly been all too ready to serve on almost any terms those who have held political and industrial power. Absorbed in the technical nature of their

[1] Abstracted for publication with permission of Senator Douglas and Marquette University.

work, they have been relatively impervious to the purposes of that which they have operated. Yet we need to recognize along with the engineers that the science and engineering techniques are neither moral nor immoral as such, but are rather amoral and can serve the degradation as well as the enhancement of life.

There is another factor which needs, I think, to be frankly faced. That is the fact that if one becomes absorbed in the manipulation of material forces, there is a natural tendency to become somewhat unconcerned about their effect on human beings. Those who have watched the post-war spread of suburban subdivisions, or the urban sprawl, know how beautiful trees and rolling countrysides have been eliminated in order to produce a deadly uniformity which can only ultimately lead to further claustrophobia.

This whole problem is highlighted by the moral dilemma created by the development of the atomic and hydrogen bombs and the development of the intermediate and intercontinental missiles. Ever since the validity of Einstein's theorem that $E = mc^2$ was established, it was inevitable that sooner or later the enormous energies within the atom would be unleashed. It was a wise decision of President Roosevelt to try to develop the bomb for, had we not done so, there was every probability that the Nazis with their own scientists and engineers would. Then science would indeed have been used to enslave the world and to destroy freedom. And freedom is a deep reality and not merely a word.

The physicists who worked upon the bomb, a large proportion from my own university, performed wonders. We all know what followed. The atom bomb was succeeded by the hydrogen bomb and fusion has achieved infinitely greater destruction than fission. As was inevitable, knowledge spread. Today, three nations have the bomb. In a few years, a dozen promise to have it. The human race now has the power to blow itself off the face of the earth. In the meantime, if the testing continues in its present form for a considerable period and is joined in by additional nations—and I emphasize all these qualifications—we may expect a marked increase in leukemia and cancer of the bones from the fallout of Strontium 90. In addition, the genetic effects upon future generations will probably be most damaging without proper control.

Now, I do not think anyone is really to blame for all this. It was indeed probably inevitable and one consequence has flowed naturally from another as did events in a Greek tragedy.

But I submit that scientists and engineers should not be indifferent to the possible terrible consequences of all this. They opened Pandora's box. They unleashed the forces within the atom. They gave men the power to achieve their own destruction. They cannot in full conscience walk away from what they have bequeathed to mankind and passively allow others to deal with the problem which they have created. We citizens need the trained and informed help of those who have let the *genie* out of the bottle.

Nor can scientists content themselves with the safeguard proposed by Francis Bacon over three centuries ago in his *New Atlantis*. For in that book which forecast the age of science, Bacon proposed a gigantic research institute called "Philosophers' House" and as his scientists let loose a new invention upon the earth, they fell upon their knees and prayed that it might be used for the benefit and not for the

SENATOR PAUL H. DOUGLAS (D-Ill.) is often described as "a farm boy who became economist, teacher, author, labor consultant, alderman, and marine." The best keynote to the Senator that we know is Collier's Magazine description of "a massive figure of intellect and integrity." Born in Massachusetts, he spent most of his boyhood on a farm in Maine, and completed his college education at Bowdoin College in Brunswick. He completed his Master's Degree at Columbia University, and studied for another year at Harvard before beginning his teaching career. After obtaining the Degree of Doctor of Philosophy at Columbia University, he became professor of economics at the University of Chicago in 1925. He was first elected to the Senate in 1948, and was reelected in 1954.

injury of mankind. But we cannot expect the Divine Power to do it all for us. We must do something for ourselves. That, I think, is what most of the great scientists such as Einstein, Urey, and others, who brought the atom into being, strove for when, with help of a great Senator, Brian McMahon of Connecticut, they worked to have the development of atomic energy under civilian rather than military control.

This was an important first step. But it was only a first step. The great issue remaining lies now in the field of international relations and the relations between the communist and free world. Here we need cool heads, brave hearts, and compassionate souls.

I am not one who blames the United States for the head-on collision which seems to be looming. The overwhelming proportion of the fault lies with the Communist rulers of Russia. They are, I believe, out for world domination. They regard us as their obstacle. They are ultimately ready to use any means if that will achieve our defeat. If they were to be successful, they would impose a police state upon us which would take away all the oxygen in our air of freedom. The experience which we went through with the Nazis and Fascists during the 30's should have convinced us all that appeasement does not pay and that determined and united resistance is necessary to defend freedom. We are now faced with an equally evil but more skillful adversary, and determined resistance should be central to all our thinking and to our acts. I am therefore *not* proposing that scientists should cease to develop the military uses of nuclear energy. On the contrary, this work must go forward.

Nurturing the Whole

I do ask, however, the engineers and scientists to work on the problem of how air contamination and radioactive fallout can be lessened whether by underground, underwater, or stratospheric explosions and to carry on a program of popular enlightenment about these matters such as a very few have been doing. Certainly the scientists should try to build up an informed public opinion not only within the free world but also within the neutral and iron curtain countries of the dangers involved in atomic testing, of the degree to which the Soviet Union is responsible for this, and of the total destruction which total war would bring. This should not weaken our will to resist and to defend freedom but it should help to build up an informed public opinion all over the world to seek a more peaceful solution of our conflicts.

In short, a free society has the right to expect its scientists and engineers to believe in freedom and to seek both to defend and enlarge it. This is to be a freedom for truth to be sifted from error by testing and by reason, to help set mankind increasingly free from excessive toil, prejudice, and passion. And in their leisure hours, I urge that they be skilled participants in movements to clean up our streams and waters from the increasing pollution, to provide adequate havens of rest and recreation, to help see to it that all communities have adequate school and library services, and that the intellectual and spiritual climate is favorable to open and tolerant discussion, to a consideration of issues upon their merits, and to the love for and practice of the joys both of pure thought and of artistic expression.

If one embarks upon this course then I predict that life will be both more interesting and more meaningful. Perhaps only a few will have the courage of the great Charles P. Steinmetz, the famous research director of the General Electric Company, who when he became chairman of the school board of Schenectady found that GE was not paying its fair share of the community's taxes and that the school children were suffering as a result. After thinking the matter over, Steinmetz arranged a series of community meetings at which he appeared and explained just what the facts were and then demanded that GE's tax assessments be increased more closely to their real value. It was a tribute to Steinmetz and the citizens of Schenectady that this was done. It is also something of a tribute to General Electric that they did not fire him, although his genius and general worth to them undoubtedly gave him a protection which men of lesser abilities would not have been accorded in their lifetime.

Lest it be thought that I exaggerate the need for scientists and engineers to be bold and creative thinkers and socially concerned citizens, let us soberly recognize the pressures which society seems to be increasingly imposing for an unthinking conformity. We are all acquainted with the type of "organization man" which is being evolved within our great corporations, our suburbs, and in our political and social organizations as well. This is the man who agrees with every dominant group or policy, and who conforms fully and exactly with the customs of those about him. Now whatever may be our

views and attitudes toward life, I believe nearly all of us would agree that in secular matters this type of attitude is distinctly *not* to be encouraged among the members of any group, and particularly not among educated men.

The world has progressed in large part because of the sense of curiosity and inquiry, coupled of course with a high sense of ethical responsibility. And it is this combination of qualities which we should seek to foster among our engineers and scientists as well as among our technicians. Colleges and universities should resist the drift to a deadening uniformity and should encourage the creative and inquiring spirit. This attitude is perhaps one of the most important quality which an educational institution can develop.

But lest I be misunderstood, I must immediately state certain qualifications to make my meaning more precise.

One should not make a convention of unconventionality and differ from prevailing customs just in order to be different. This I suspect is the intellectual error into which the young beatniks have rushed. The mere growing of a beard and the wearing of blue jeans and dirty sweaters are not desirable qualities in themselves, nor do they indicate any true originality of spirit. Nor is the embracing of unpopular political and social opinions necessarily a virtue in itself. What I am asking for is not blind and sentimental revolt but a considered, ordered, and socially based independence of mind and spirit which gladly supports the good features of our society even as it seeks improvement.

Secondly, as I stressed earlier, while reason should have its dignified and proper place, the ethical and spiritual imperatives should be controlling. As Pascal wisely observed, "the heart has reasons which reason knows not of." It is my own faith that this imperative should be the desire to embody and to transmit the spirit of Christian love and to help create an ever broader fellowship bound together by love and good will. This too is a part of the education of the whole man which a free society should expect and try to provide, and even cultivate.

Transcension

And now may I add another note which to many may seem minor. Our scientists and technicians should also be cultured men who can cultivate the gardens of the mind and spirit. Technical competence in itself seems graceless. To raise life to its highest level of attraction there should be some cultivation of hobbies and some deep interests outside of one's work and one's duty as a citizen. The world has been a fascinating place for a long time and so it is today. The great masters of literature—Shakespeare, Goethe, Tolstoi—have plumbed the problems of human existence to the depths and to read them is to experience in a vicarious fashion the intensity and mystery of life. The Sistine Chapel is one of the glories of the world, and the incomparable Michelangelo who painted those breathtaking frescoes was probably the greatest artistic genius of the race. His paintings, his sculpture, and the perfectly swelling dome of St. Peter's which he created are works to become acquainted with and to love. And how much richer our lives are for Bach, Mozart, and Beethoven and how close at hand they now are for us to hear and to enjoy. And nature outdoors beckons to us in lake and mountain, forest and plain, with a wealth of animate and inanimate life which we can enjoy.

And what about the history of the human race itself, of the rise and fall of empires, the movements of thought, the formation and functioning of religious societies, and the broadening ethical consciousness of man? Could anything be more commanding than these? And may we not be moved to reverence by such lives as St. Francis, St. Dominic, and St. Benedict, and by such modern embodiments of the true and the good as Albert Schweitzer and Jane Addams?

In short, to the educated man life should never be boring and despite the competitive struggle for excellence and for success there is now being provided sufficient leisure for the human spirit to expand.

The great engineers and scientists have always been more than mere technicians and as men have transcended their occupations. Pascal was a theologian as well as a mathematician. Steinmetz was an accomplished organist, as is Albert Schweitzer. Herbert Hoover took a year off from his early career as a mining engineer to study Latin and to translate Agricola's work on mining and minerals. John Hays Hammond was a man of almost endless interests.

I am not asking that men should become dilettantes and neglect their work. Far from it. But life is long and its facets innumerable. As we go through life let us savor its richness as we pass. And youth is a good time in which to begin. And most of these latter qualities must be imparted by example, rather than by formal discipline or dictates.

THE COMMON DENOMINATOR

By ROBERT STOLLBERG

Professor of Physical Science, San Francisco State College, California

THE task of the research scientist is sometimes a solitary one; not so that of the teaching scientist. The activities of the science teacher consistently concern other people—students and colleagues, scientists and technicians, educators and citizens. True of the individual science teacher, this Common Denominator of cooperative endeavor is vastly more significant for an organization of science teachers. The activities of NSTA have brought us distinct advantages and rewarding results through cooperation with individuals and groups representative of government and private industry, colleges and universities, research laboratories, and professional societies, not only in the U. S. but throughout the world.

We have experienced cordial working relationships with groups whose programs and goals are characteristic of our own, and we have learned of other activities and interests unknown to us that have helped in molding our own programs. We have accepted high praise and caustic criticism alike from our organizational associates. From these we have learned much, and we hope this has not always been a unilateral process. A guiding policy of our Association has been to work with other groups toward mutual goals. For by its very nature, NSTA is an organization which does not—and cannot—live alone.

On this occasion of the 15th anniversary of NSTA, we have asked representatives of some of these cooperating groups to speak on their behalf and ours.

The National Science Teachers Association is one of thirty (and seventh oldest among) departments of the National Education Association. We therefore look on this important and influential Association as one of our professional progenitors. Our headquarters staff, established in 1948, is housed in the NEA Building in Washington, D. C., and we receive professional advice and administrative services from the parent organization.

By **WILLIAM G. CARR**

Executive Secretary, National Education Association

The National Education Association takes great pride in the work of its departments. These units represent most major aspects of education. The Association delegates to departments the important task of dealing with the *specialized* needs of classroom teachers and other educators as they seek to improve the instructional process or perform other tasks.

The NEA, through its headquarters divisions and committees, promotes the welfare and professional development of teachers, carries on public relations and legislative programs, defends teachers and schools, and otherwise deals with the problems in which *every* member of the profession has a concern.

The NEA is stronger as its departments develop, and the departments are strengthened as the NEA grows in the power and wisdom which it brings to bear on the educational problems of our democratic society. With the increased emphasis on science since World War II, it would seem imperative that the NEA structure include a service for science education. Happily, the Association had a department for science which, with modest financial assistance from NEA, stepped into the breach and has carried out this function with great distinction. During these intervening years, the direct financial support of NSTA by the NEA has totaled $51,000. Meanwhile, NSTA has procured and invested nearly two million dollars in service and activities. We have watched with pride such specific projects as the purchase and growth of this magazine, the establishment of NSTA's Future Scientists of America Foundation, and the development of regional meetings and plans for an Annual Convention (now in its 8th year) for science teachers.

With the completion of the new NEA Center in Washington, NSTA now has adequate and up-to-date headquarters for its staff. It should be remembered, however, that the NSTA, like other departments of NEA, has had the volunteer services of hundreds of members without whose cooperation its program would be impossible.

Substantial continued growth in this important and vital department of NEA appears assured. In view of the scientific needs of our country and of the world, it would be a bold man indeed who would set limits to the future growth and usefulness of this great group of teachers.

Dr. Carr joined the NEA headquarters staff in 1929, coming directly from the California Teachers Association where he was director of research. His first post was as director of the NEA Research Division and later as associate secretary of the Association. Teacher, administrator, and consultant in education areas, he also serves as secretary-general of the World Confederation of Organizations of the Teaching Profession.

The other distinguished "parent" of NSTA is the American Association for the Advancement of Science of which we are an affiliated group. We have an active role during Christmas week in the annual national meeting of this far-flung Association, and we enjoy the reciprocal relations and interests with other groups of professional scientists, which are also affiliated with the AAAS.

By DAEL WOLFLE

Executive Officer, American Association for the Advancement of Science, Washington, D. C.

The annual meetings of the American Association for the Advancement of Science bring together a multitude variety of people who are interested in science: Nobel Prize winners and high school students, science teachers and science writers, industrial, government, and academic scientists, and anyone else who cares to attend. The provision of a common meeting ground for all fields of science and for variegated interests in science is one of the basic functions of the AAAS.

The NSTA is a regular and especially welcome participant in these annual meetings; especially welcome because holding NSTA and AAAS meetings together provides many opportunities for scientists and science teachers to get together to talk about common problems.

NSTA and AAAS are also both members of the Cooperative Committee on the Teaching of Science and Mathematics, which was established by the AAAS in 1941, and has been functioning effectively ever since. The Cooperative Committee provides a semiannual opportunity for representatives of societies of scientists and societies of science teachers to compare notes and to plan cooperatively for the improvement of science.

One of the basic operating principles of the AAAS is that substantial and lasting improvement of science teaching can be achieved only through the cooperative efforts of scientists and science teachers. In this cooperative effort, the NSTA and the AAAS have each called on the other for help in committee service, in planning new activities (such as the Science Teaching Improvement Program of the AAAS), in providing information, or in criticizing contemplated programs intended to improve science teaching.

The AAAS officers appreciate greatly the continuing help and close collaboration with NSTA.

The National Science Foundation is a relatively recent government agency and many of its activities are by nature closely related to our own. NSTA staff and representatives have often served in an advisory capacity to NSF, and we have similarly profited from the experience and counsel of its representatives. The Foundation has provided grants in support of certain NSTA activities.

By ALAN T. WATERMAN

Director, National Science Foundation, Washington, D. C.

It has been the policy of the National Science Foundation to work closely with the scientists of America and their professional scientific and educational societies in carrying out its responsibilities with respect to education in the sciences. This policy has been based upon our conviction that the problems in science education must be solved by the scientists and the science teachers themselves within the general framework of the scientific and educational community — the schools, the colleges, and the professional associations, and related groups.

It is a pleasure to have this opportunity to commend the officers and staff of the National Science Teachers Association—both present and past—for the service which the Association has performed in helping the science teachers of America to meet their rapidly increasing responsibilities.

During the past few years, the National Science Teachers Association and the National Science Foundation have found many ways in which cooperative undertakings have been of mutual value. These have ranged from informal talks and conferences to contracts for the performance of services for which the Association is uniquely equipped to carry out.

One of the most difficult of the problems with which the Foundation has had to cope in the administration of its programs for supplemental training for science teachers is that of communication with the teachers themselves. The National Science Teachers Association has helped in many ways to solve this problem. Program announcements in *The Science Teacher*—particularly with respect to the Foundation's Institutes Programs—have been very helpful. In addition, cooperation by the Association with the Directors of Summer Institutes in providing mailing lists of prospective applicants has been an invaluable service. The current "United States Registry of Junior and Senior High School Science and Mathematics Teaching Personnel" (maintained jointly by the National Science Teachers Association and the National Council of Teachers of Mathematics, with support from the National Science Foundation) is a significant step forward in fulfilling the need for more information about the Nation's science and mathematics teachers.

The Association participated in the planning and organization of the Physical Science Study Committee, and the Executive Secretary served as a member of the Steering Committee.

In conclusion, we are appreciative of the effective ways in which the National Science Teachers Association is working both to serve and to represent the science teachers—and with respect to the National Science Foundation these efforts have been highly productive and useful.

Although NSTA has no legal relationship with the U. S. Office of Education in the Department of Health, Education, and Welfare, our cooperative efforts with USOE have been significant in scope and impact through the years. We often seek advice and services whenever needed, and when possible we return them in kind.

By LAWRENCE G. DERTHICK

Commissioner, U. S. Office of Education, Department of Health, Education, and Welfare, Washington, D. C.

The increasing importance of science in the lives of people and in the general welfare of the Nation has focused the attention of educational leaders and science teachers on the Capital.

With the bonds of cooperative efforts so firmly established over the years of association and with the science teachers of the Nation seeking leadership it would seem that the future holds considerable promise for endeavors of mutual interest as we pursue the goal of raising the level of science teaching in the public and private schools of America.

The United States Office of Education is pleased to extend greetings to the National Science Teachers Association upon the completion of fifteen years of devoted service to the cause of science education in America.

The rapid increase in your membership, the growth of your annual budget, your excellent publication program, and other increasing services rendered by the Asso-

ciation, together with the numerous special program achievements over the years all testify to the important place which the National Science Teachers Association occupies in education.

The National Defense Education Act, passed by the Congress last September, is attempting to improve certain aspects of science teaching. The Office of Education has been gratified with the part which the National Science Teachers Association has taken, both in support of this Act, and in planning for its implementation in the schools of the country. There has been further cooperation between the two agencies regarding the Federal legislation for science clubs and science fairs.

Since the inception of NSTA, the Specialists for Science in the Office of Education, together with other Office personnel, have enjoyed cordial and cooperative relations. Joint conferences and publications have been sponsored from time to time and in other ways common purposes and goals have been pursued together. For these relations and cooperative endeavors the Office of Education is deeply appreciative to the National Science Teachers Association and looks forward to future endeavors.

Many representatives from American industry have been quick to see that the activities and goals of the NSTA are consistent with their own. Accordingly, an active facet of Association organization is the Business-Industry Section. Through this function, individual representatives of many commercial and manufacturing groups are able to meet and explore business-industry-education objectives and programs. These friends from the nation's economic life-line are welcome members of the NSTA family.

By JULIAN STREET, JR.

Chairman, Executive Committee Business-Industry Section, NSTA

"If you tell me that you desire a fig," wrote Epictetus in his *Discourses,* "I answer you that there must be time. Let it first blossom, then bear fruit, then ripen."

This allusion seems to us—the members of the Business-Industry Section—an appropriately symbolic salute to our parent, the National Science Teachers Association, on its fifteenth birthday. For these fruitful years have brought a vigorous growth and flourishing accomplishment to NSTA. During the eight years since the birth of the B-I Section, like Epictetus's fig, our relationship with NSTA has blossomed, borne fruit, and ripened.

In particular, we pay tribute to the NSTA official family, including its officers and directors as well as the professional staff. These persons have displayed unusually patient perseverance in cultivating our common interests in the groves of science. It was they who had the foresight to see that neither education nor industry could afford to live in intellectual isolation from one another. It was at their instigation that criteria and guidelines were established which paved the way for this unique tie between industry and the teaching profession.

Among our 289 B-I members are representatives of 182 companies and trade associations who share with science teachers a common concern regarding the education of our young for the Era of the Atom and the Age of Space.

Our program aims to further sound educational standards and to provide up-to-date information for teachers and students in a science-oriented society such as ours.

More specifically, we plan in the immediate future to show how the educator and the businessman may work together to make plant tours, supplementary teaching aids, science fairs, and similar activities, a still more enriching educational experience. For it is through such tools as these that we shall jointly work toward the ultimate goal of igniting the imaginations and the disciplined curiosity of our most valuable resource of all—the nation's youth.

Although the major part of NSTA activity is related to secondary and elementary schools, we are also concerned with matters of higher education. We have ideas about post-high school learning in science and are aware of the problems of articulation between high schools and colleges. We acquire much of our knowledge about the subject of science and the philosophy of science education from our colleagues in colleges and universities, and maintain a continued interest in this aspect of learning.

By HUBERT N. ALYEA

Professor of Chemistry, Princeton University, Princeton, N. J.

Grade school teachers, high school instructors, college and university professors—we are all in the same business, the business of selling intellectual curiosity to our students. And this common denominator of purpose is what makes NSTA just as valuable to the college professor as to the grade school teacher, or other members.

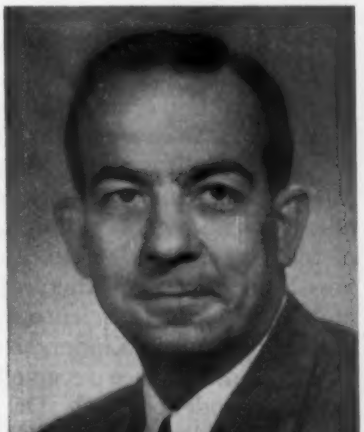
There are many contacts of mutual interest in the Association activities. *The Science Teacher* constantly supplies us with stimulating ideas for presenting our material, with new facts to present, with corrections of misconceptions (e.g., the idea that the motion of man-made planets involves centrifugal force). Most important to the college professor is the help it affords in understanding the kind of preparation his pupils have had before they come to him, an appreciation of their scientific background which is paramount to a sympathetic teaching program.

NSTA conventions provide a common market place for the exchange of professional ideas between teachers at all teaching levels, from which we draw the strength that comes from the professional pride of being science teachers, rather than teachers of science. Here, too, we learn new ways of doing things in the classroom or laboratory; here new science projects take shape during conversations with our colleagues. For at our teaching levels, we have the same professional status as scientists, with the same professional drive to teach others about our fascinating field and related subjects.

Then there are many other NSTA activities from which the college professor benefits—the science institutes both during the summer and throughout the year, where teaching ideas can be continuously examined, criticized, praised, accepted or rejected, altered, and exchanged. This is a growing process in which NSTA catalyzes the interaction of teacher with teacher.

These are but a few of the many tangible assets which I as a chemistry teacher in a university find of continuing value in my association with NSTA.

Dr. Stollberg, professor of science and education, introduces some of the members of our cooperating groups and associations. As president of NSTA in 1955-56, Dr. Stollberg has worked with many of these groups toward achieving Association goals. A native of Ohio, he graduated from the University of Toledo in physics and education; attended Columbia University for his Doctor's Degree in science education in 1947. His professional activities in elementary and secondary science teaching enable him to contribute sound and consistent direction to our program.



Beginning from ZERO

By HANOR A. WEBB

Department of Science Education, Peabody College for Teachers, Nashville, Tennessee

"The evil that men do lives after them, the good is oft interred with their bones."—Mark Antony in *The Funeral Oration over Julius Caesar*, William Shakespeare.

How wrong can a philosopher be, if the "men" are science teachers—or indeed, *any* teachers!

The story we tell is of men and women of vision, of wisdom, and above all of professional spirit. Their common desire was to improve science teaching throughout our nation. Their service was the initiation of movements among their fellows that have grown to the present highly influential organizations of science teachers—in this record, the National Science Teachers Association and its affiliates. Are these developments of their earnestness and energy "interred" today? The question is rhetorical—the answer is "No!"

Our National Science Teachers Association had its beginning in the mind of Dr. Charles Skeele Palmer of the University of Colorado, Boulder. He enthused others to join in the organization of a Colorado State Science Teachers Association in December 1894, with the chief purpose of planning for a national association to be launched at the meeting of the National Education Association in Denver, in July 1895. A committee was appointed to confer with officers of the NEA as to a Department of Science, there being precedents in the recent organization of departments of teachers of Art, Music, Industrial Arts, Business Education, and others. In the existing Secondary Department, science was rarely discussed; in the programs of Kindergarten and Elementary Departments science received no consideration.

Correspondence with Dr. Nicholas Murray Butler, President of the NEA and of Columbia College (later University), and with Dr. Irwin Shepard of Winona, Minnesota, Secretary of the NEA, was encouraging. A circular was prepared by Palmer and others for extensive mailing through the United States. It was hoped by this to attract a large number of science teachers to the NEA's Denver meeting.

The circular is well written and detailed; it may only be summarized here. Its full text is in *Addresses and Proceedings of the National Education Association. Denver, Colorado, 1895,* pages 951-958.

The first and second paragraphs described the state organization of Colorado's teachers of natural science of both secondary and college levels.

The third paragraph described the aims:

"The aim is to limit the number of science subjects taught [often as many as twelve separate sciences in a single high school]; to insist that each subject [retained] shall cover at least one year; to improve the methods and matter of laboratory work and all that is implied therein; to determine, if possible, the proper order of the natural sciences suitable for, and fundamental to, the courses of the secondary school." (These ideals were hardly attained until the influential U. S. Office of Education's Bulletin No. 26, 1920, *Reorganization of Science in Secondary Schools,* written by Dr. Otis W. Caldwell's committee, was published and widely distributed.)

The fourth and fifth paragraphs announced a Round Table Conference to be held at the NEA's Denver meeting in July, "with eminent teachers of national reputation present," and exhibits of scientific equipment. Hope was expressed that attendance and interest at that meeting would

justify application to the NEA for the organization of a Department of Science Teachers.

The sixth and seventh paragraphs described advantages of such a department to science teachers in secondary schools and colleges. The circular was signed by Charles Skeele Palmer of the University of Colorado, Boulder; Charles J. Ling of East Denver Manual Training High School; William Triplett, Superintendent of Golden Schools; H. V. Kepner of South Pueblo High School; and A. J. Floyd of Greeley High School. Many replies were received.

Has the "good" of this circular—planned by these earnest men—been "interred with them?" Read on!

We Begin

The Round Table meetings were held in the Lutheran Church, California and Twenty-second Streets, Denver, at 2:30 p.m. Wednesday, July 10, and Friday, July 12, 1895.

Attendance at the First Round Table is not reported. It was called to order by Charles S. Palmer, who was promptly elected chairman. Although many helped to plan this meeting, it is obvious that Palmer was the leader and—if one must be singled out—the principal founder of our Association. The group elected Charles J. Ling as secretary.

The first speaker was Dr. Nicholas Murray Butler, president of the NEA. No more distinguished "first on the first program" could have been selected. Dr. Butler was at the height of his educational service and influence, the "Number One Educator" of the day. We who have spoken since at our Association's meetings are echoes of eminence!

Among Dr. Butler's remarks were these: "It has taken four hundred years to organize science into its now accepted subjects. Indeed, only since Darwin [1809-1882] and Helmholtz [1821-1894] have ideas of science been clarified and classified. The school and the teacher must realize this disadvantage against subjects which have been long settled pedagogically.

"The history of science as a requirement for college entrance shows that the worst enemies of science teaching are science teachers in the highest positions. The highest function of science teaching is to deal with the various aspects of the pedagogical of science subjects. We ought to know from scientific men what subject matter ought to be taught, the order, and conditions."

Problems to be answered by scientific men: coordination of subjects, science in elementary schools, relation of science to other subjects. Dr. Butler's conclusion: "The educational value and pedagogical forms of science can be put in a valuable form, and will be second to none if this problem can be put fairly and accurately on a pedagogical basis before teachers."

How do *you* interpret these concluding words of Dr. Butler? May I try? If the term "pedagogical" may be simply expressed as "how to teach it," it seems that he was arguing firmly against the oft-repeated phrase—almost a slogan—of the college specialist: "If you know your subject, you can teach it!"

Succeeding speakers at the First Round Table voiced various ideas. Professor Bessey of the University of Nebraska argued strongly that botany, zoology, and physiology should be taught separately: "I do not believe in 'biological science.' "

Professor Atkinson of the Department of Cryptogramic Botany, Cornell University, after admitting that he had never taught in any secondary school, gave in detail how gross anatomy of plants should be the first biological subject that ought to be offered in high school.

Professor Jackman of the Cook County (Ill.) Normal School spoke of his methods of teaching science in the grades (for which he was already famous), urging a practice of "much observation in the freedom of field excursions, where the restraints of the schoolroom may be thrown aside." Mr. Otis Ashmore of Savannah, Ga. told of excursions with his high school classes to the ocean beaches.

In the light of modern (and your own) attitudes, would you assert that the addresses of the first meeting of our Association's history were (a) wholly wise, (b) altogether foolish, (c) part wise and part foolish? Mark your ballot, cast it in the wastebasket, but remember your choice.

Attendance at the Second Round Table was 75. Dr. Joseph LeConté of the University of California, the nation's most noted geologist, spoke eloquently. He referred to the sciences as "a revival of learning, as the Book of Nature rather than the Book of the Ancients is spread before us." He strongly supported the formation of a Department of Natural Science Teaching in the NEA structure.

The following officers—our first—were elected: president, Charles E. Bessey, Lincoln, Nebr.; vice-president, Wilbur S. Jackman, Chicago; secretary, Charles S. Palmer, Boulder, Colo.

The addresses and discussions that followed were chiefly devoted to physics and chemistry,

especially as to which of these sciences should be presented first in high school. Disagreement was strong, argument vigorous.

A committee was appointed to present a formal petition to the Board of Directors, NEA, with Dr. LeConté as spokesman. At the Board's meeting the petition was unanimously granted, and the Department of Natural Science Instruction (its first official title) was in existence.

The second meeting of the Department of Natural Science Instruction was at the Buffalo meeting of the NEA, July 9 and 10, 1896. Professor C. E. Bessey of Nebraska presided. The attendance, 150. Among the addresses given were these: Professor C. E. Bessey, University of Nebraska, "Science and Culture"; Professor H. S. Carhart, University of Michigan, "The Humanistic Element of Science"; Professor W. S. Jackman, Cook County Normal, "The Study of Science in the Elementary Grades"; Professor John M. Coulter, University of Chicago, "The Educational Value of Botany"; Professor Simon H. Gage, Cornell University, "Zoology as a Factor in Mental Culture." These, and summaries of the discussions are presented in full in *Addresses and Proceedings of the NEA, Buffalo, 1896*, page 939-967.

Does it interest you to notice that each speaker was a college professor, and—except for Jackman—a specialist? Some of us may consider that this was a dangerous start, yet the plan continued for many sessions. Do you have an explanation?

It is a temptation to continue the recording of speakers and titles for succeeding years, for they indicate the thinking of the leaders (yet not necessarily the wisest) among science teachers of the time. It is not practical to publish these details in full, therefore will you trust *me* to select and report speakers of eminence, and titles of significance in the development of science education? All in favor say "aye"; opposed "no." The "ayes" have it; I will proceed.

1897, *Milwaukee*. Alexander Smith of the University of Chicago, noted teacher of chemistry and author of the most widely-used text, presented an address.

1898, *Washington*. Reports of sub-committees on physics, chemistry, botany, physical geography, and zoology as high school subjects, each read by a college professor of the science. Total speakers, six college professors, and one high school teacher.

1899, *Los Angeles*. A delightful quotation from President Elliot of Harvard: "Two kinds of men make good teachers—young men, and men who never grow old!"

1900, *Charleston*. Brief program on nature study. During this year a science teachers' magazine was conceived in the mind of C. E. Linebarger of Lake View High School, Chicago. With the aid of others it began issue in March, 1901; its name, *School Science* (now *School Science and Mathematics*.) This stimulated the organization of the Central Association of Science and Mathematics Teachers, which met first in Chicago, April 9, 1903. Charles H. Smith of the Hyde Park High School, Chicago, was the first president. The full story of this flourishing contemporary of our own Association is told in an anniversary volume, *A Half Century of Teaching Science and Mathematics*, published by the Association in 1950.

1904, *St. Louis*. Dr. Otis W. Caldwell participated in the discussion.

1908, *Cleveland*. The American Nature Study Society held its first meeting on January 2, 1908, in Chicago. The driving forces behind this organization were Liberty Hyde Baily of Cornell and Maurice Bigelow of Columbia. From the beginning the Society invited to membership "any person interested in any phase of nature and elementary science." Its journals are *Nature Magazine* and *Canadian Nature*. The history and philosophy of this Society are told in a dramatic article by E. Laurence Palmer, "Fifty Years of Nature Study and the American Nature Study Society," *Nature Magazine*, December, 1957, pages 473-480.

1909, *Denver*. Dr. Otis W. Caldwell, president, spoke on "Science as a Foundation for Modern Industry." He was a prophet indeed!

1911, *San Francisco*. Three of the many papers made the first mention of general science as a desirable subject for high school. (You may be interested in the article, "How General Science Began," by Hanor A. Webb, *School Science and Mathematics* LIX, 421-430, June 1959.) General science was not mentioned again on the program for four years.

1915, *Oakland*. A high school teacher favored general science; a college teacher opposed. U. S. Commissioner of Education, P. P. Claxton, spoke on "The Cultural Value of Science Instruction."

1916, *New York City*. Five sessions, one being a symposium on the training of science teachers. John Dewey spoke on "Method in Science Teaching." (See *The Science Teacher*, 22:119, April 1955.)

Palmer Butler Caldwell Carpenter Eikenberry

1917, *Portland.* Chief topic, science for war.
1918, *Pittsburgh.* Science for war again.

1922, *Boston.* A feature address, "The Science of Outdoor Life," by William G. (Cap'n Bill) Vinal of Cleveland, who in 1959 is still speaking on the same subject!

1923, *Oakland-San Francisco.* A challenging paper, "Why Teach Science At All?" *Your* answer?

1924, *Washington.* 1925, *Indianapolis.* Shall we mention the first appearance on these programs of an earnest, middle-aged Tennessean —Hanor A. Webb, "Types of Investigations in Science Teaching?" All in favor say "aye"; opposed, "no." The "noes" have it, and no mention will be made.

1926, *Philadelphia.* The program featured nature study, with Mrs. Anna Botsford Comstock of Cornell the chief speaker.

1928, *Minneapolis.* A feature address by Samuel Ralph Powers of Teachers College, "Needed Research in Science Teaching." A modest note—Hanor A. Webb, presiding.

On February 27, 1928, the National Association for Research in Science Teaching was organized at Cambridge, Mass., chiefly through the efforts of W. L. Eikenberry of State Teachers College, East Stroudsburg, Pa. He was elected first president, and S. Ralph Powers of Teachers College began a service of more than a decade as secretary. A rapidly moving story of the first quarter-century of this Association is told by Ralph K. Watkins, "The Beginnings, Early Membership, and Early Activities of NARST," and by Hanor A. Webb, "The Growth and Activities of NARST," in the Silver Anniversary Issue of *Science Education,* 37:11-21 (February 1953). The Association flourishes today.

1933, *Chicago.* In December 1933, more than one hundred science teachers met in Boston at the invitation of the Committee on the Place of Science in Education of the American Association for the Advancement of Science, Dr. Otis W. Caldwell, Chairman. They wished to consider the formation of an association of science teachers affiliated with the AAAS. For decades this major organization of scientists had held no programs devoted to the problems of teaching science. The Sections named for the sciences presented papers on research; even Section Q, Education, considered chiefly statistical and psychological reports.

During the year, chiefly through the efforts of Harry A. Carpenter, Specialist in Science, Rochester (N. Y.) Public Schools, it was learned that many local science clubs and teachers' groups would federate with a national organization such as he proposed. Attendance of teachers at the December meetings of the AAAS as part of that Association's program promised to be satisfactory. The Department of Science Instruction, NEA, during its 38 years of existence, had never sought such affiliations throughout the nation, for reasons that seemed wise to its officers.

Dr. Carpenter and his committee arranged a program meeting at Pittsburgh, during the December, 1934 meeting of the AAAS. An interesting precedent was established in that the luncheon meeting was addressed by the president of the AAAS. This meeting was also addressed by such notables as Dr. Edward L. Thorndyke and Dr. Robert A. Millikan. There was also much discussion of the problems of an Association such as had been proposed.

An organization committee was appointed with Harry A. Carpenter chairman. This committee reported a year later (January 2, 1936, at Saint Louis, with details of a constitution and plans of operation. Next December, 1936, at Atlantic City, the AAAS accepted the American Science Teachers Association as "an associated organization." Harry A. Carpenter was installed as president. Programs were given at AAAS meetings until 1942.

In 1935, Ira C. Davis, of the University of Wisconsin, president of the Department of Science Instruction, NEA, and his advisors, initiated a program of invitations to science teacher groups for affiliation. This was carried on with much earnestness, and with considerable success. As a result, many science teachers held membership in both groups (DSI of NEA and ASTA of AAAS) as well as in their local organizations. A feeling developed that these two national science teachers' groups were competing for memberships and for affiliates to a degree that was not in the best interests of the profession. For this reason the merger of these two chief science teachers' organizations in 1944 was accepted by many with some relief.

An interesting account of these early meetings is given by Otis W. Caldwell in "The American Science Teachers Association," *School and Society,* May 25, 1935.

1938, *New York City.* During this year the National Association of Biology Teachers was organized, for the purpose of greater specialization in this area.

1939, *San Francisco.* A new problem—how shall $1000 granted by the NEA be spent for some worthy development? A new feature—a treasurer and dues of 50¢ a year. A constitutional revision—establishing four regional vice-presidents. Organization of a National Council on Science Teaching was discussed, with a full time Executive Secretary and headquarters proposed in the National Education Association's building in Washington.

1940, *Milwaukee.* A proposed constitution for a Council on Science Teaching was read by Philip G. Johnson of Cornell. It was obvious that important changes in the organization and activities of the Department of Science Instruction impended.

1942, *Denver.* The Department of Science Instruction reorganized as the American Council of Science Teachers. The word "American" was considered to be more suitable than "National" to designate the scope of the Council.

The National Committee on Science Teaching, appointed the previous year, gave three reports. Highly detailed plans for local sections, affiliation with State science groups, and other cooperative activities, were presented.

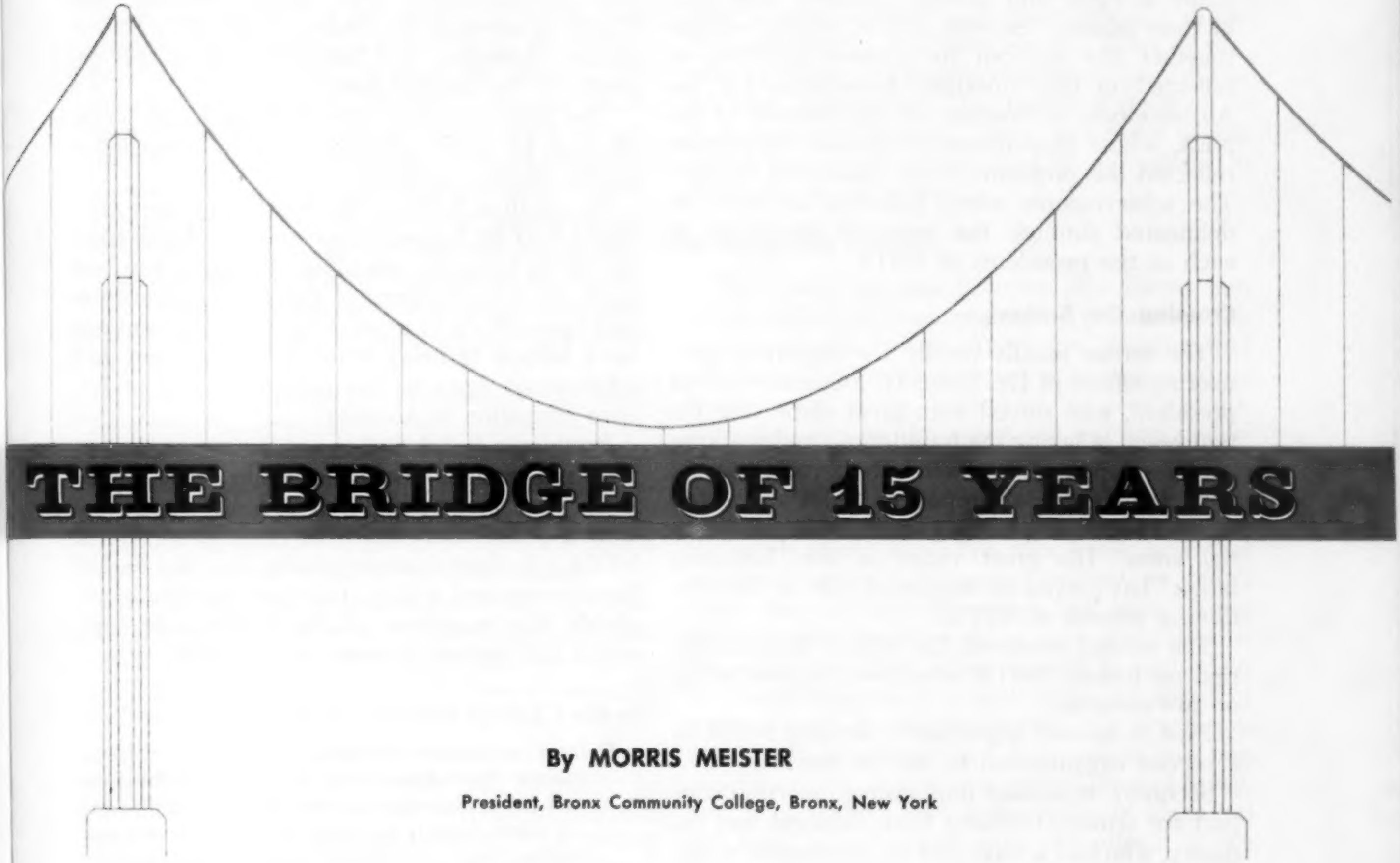
1943, *Indianapolis.* Philip G. Johnson, first president of the American Council of Science Teachers, presided. Annual dues were set at $1.00. *The Science Teacher,* edited and published for several years by John C. Chiddix of the High School, Normal, Ill., was adopted as the official journal.

1944. No meeting of the Council was held. The armed forces and industries had called many science teachers from their classrooms. Nevertheless, membership in the Council increased 70 per cent during the year and a number of science groups affiliated.

It was in this year of stress that two major organizations—the American Council of Science Teachers and the American Science Teachers Association—merged and the National Science Teachers Association, whose birth this volume celebrates, began its service. This was the end of one era and the beginning of another. Permit a paraphrase—"the good that men do lives after them, and we cherish their memory!"

A most competent historian of science education has been given the assignment to tell the rest of the story. *Take it away, Morris Meister!*

Our notable historian, Hanor A. Webb, emeritus professor of chemistry and science education, George Peabody College for Teachers, Nashville, Tennessee, has been a pioneer in many forward movements in science education, including the founding of NSTA. Dr. Webb has ably outlined the early steps taken to form our Association. He has been active in science education for 50 years since his early days at the University of Nashville and the University of Chicago.



THE BRIDGE OF 15 YEARS

By MORRIS MEISTER

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SCIENCE teachers in America have always shown an independence that has been unique among professional groups of teachers. They do not seem to get together too easily. They have a propensity for forming strong local associations. In this respect they differ somewhat from teachers of English, teachers of social studies, teachers of language, mathematics, and health education, all of whom have succeeded in forming large national and well integrated professional associations.

In 1944 science teachers were giving their support to such important national groups as the National Association for Research in Science Teaching, the Central Association of Science and Mathematics Teachers, the National Biological Teachers Association, the American National Study Society, the American Science Teachers Association, and the NEA Department of Science Instruction. With the merger of the last two under the banner of NSTA, the bridge began to span. While all the organizations listed are still in existence, quite active, and doing fine professional work, there is no doubt that NSTA has won the greatest amount of support among teachers of science in America. NSTA has now become the strongest voice in behalf of science teaching in this country.

Reviewing some of the discussions and minutes of the 1944 merger meeting in Pittsburgh, this significant paragraph sets up the important goals during the early beginnings of the NSTA:

> As we see it, we are heading: (1) toward a new outlook in science education, (2) toward a greater concern with excellence in educational product and better conservation of human resources, (3) toward the development of new kinds of higher education for most of our able young people, (4) toward extended scientific literacy for the citizens, (5) toward science as a humanistic study, (6) toward new concepts of teacher preparation and teacher methods, (7) toward new meanings and new conflicts generated by the scientific age.

As is often the case with hybrids, they demonstrate a vigor and strength greater than that of their parents. So with NSTA, which brought together the concern for science teaching as reflected in the American Association for the Advancement of Science and the interest of the NEA, whose Department of Science Instruction reflected the problems of the classroom teacher. The achievements which followed can best be delineated through the essential objectives of each of the presidents of NSTA.

Crossing the Bridge

The writer recalls vividly the important pioneering efforts of Dr. Philip G. Johnson, our first president, who served with great distinction for two years, in laying the foundations and marking out lines of potential growth. He devoted himself to bringing financial support to NSTA and to the establishment of planning committees in essential areas. His great vision as the "founding father" has played an important role in the continuing growth of NSTA.

The second president, Dr. Morris Meister, carried on toward NSTA objectives, concentrating on two essentials:

First, it seemed important to develop NSTA as a service organization to science teachers;

Secondly, it seemed important to marshal support for science teaching from business and industry, who had a stake and an investment in the country's program in science education.

As a result, the next two years of NSTA operations gave major attention to the Packet Service and the creation of a strong committee on relations between science teaching and industry. Both programs flourished and had their repercussions in a revitalized magazine to our membership. All of this gave rise to a very busy central office at the NEA. It became increasingly clear that NSTA would never realize its full potential unless it could command the services, full time, of an Executive Secretary, with all the assistance that his office would require. This meant financing on a scale for which the membership dues and other sources of revenue were quite inadequate. Out of this need came two very important developments which counted heavily in the later success of NSTA.

First, the financial help given to us by NEA.

Secondly, the appointment of Robert H. Carleton as Executive Secretary.

In the writer's humble opinion, the most significant event for NSTA was the gathering at the home of Dr. Meister in August 1948, to welcome Mr. Carleton to this newly created position. Mr. Carleton assumed the duties of his office immediately thereafter and has continued in this capacity to the present date.

The third president, Mr. Norman R. D. Jones, devoted his year's administration to a successful membership campaign.

Dr. Nathan A. Neal, the fourth president, initiated NSTA's National Conventions. These have served to focus the attention of science teachers upon the key problems of the science classroom and upon efforts to solve them. The conventions have helped to bring home to government and educational agencies the pressing needs of science education in America.

Presidents Ralph Lefler and Arthur O. Baker, fifth and sixth in sequence, made great strides with our professional journal, *The Science Teacher,* by that time the sole property of NSTA. In their administrations, too, the Packet Service reached a high tide and justified completely the soundness of the CEDUR formula which had guided the service since 1947.

In the CEDUR formula, we have:

C for consultation—a number of NSTA subject-matter specialists were selected and business and industrial organizations were invited to call on these experts for help in planning and producing their educational materials intended for use in schools.

E for evaluation—no instructional material is ever included in a packet without prior evaluation of its content, accuracy, and appropriateness for the classroom, regardless of financial subsidy or pressure. The Evaluation Committee has examined well over 2500 items to date.

D for distribution—Packets are sent to all members of NSTA, but in addition many items of packets are frequently sent to a much larger list of teachers including those on NSTA's U. S. Registry of science teaching personnel.

U for utilization—Many packet items have triggered ingenious teaching methods, enlivened class discussions, and stimulated students to do projects, or contributed to making learning more effective; studies looking toward improved utilization have been carried out by NSTA committees.

R for research—The kind of instructional material produced by industry is only at the beginning of its growth. Research will help to realize their potential of usefulness. In this effort, industry and science teachers must continue to work together.

Dr. Harold E. Wise, Dr. Charlotte L. Grant, and Dr. Walter S. Lapp were at the helm of NSTA during the next three years. Each of them gave steady direction and stability to the rapidly growing organization. Among the many developments for the years 1952-1955, we can list at least these five important ones: effective machinery for enlisting support of regional groups of science teachers; attracting financial support through grants of various kinds; organization of a series of awards to science teachers and to their students; "How to Do It" sessions at NSTA conventions; and a series of studies designed to evaluate a variety of science teaching equipment and apparatus.

Dr. Robert Stollberg's administration in 1955-1956 was characterized by the prominence of activities undertaken by the Business-Industry Section, an off-shoot of the earlier council on improving relations between industry and science teaching. Dr. Stollberg did much to attain for NSTA the full potential value of this relationship.

Dr. John S. Richardson, eleventh NSTA president, took full advantage of NSTA's progress and extended the scope of its work into new areas. He pointed the way to needed areas of research to find better guidance for meeting the country's needs in science education.

Doctors Glenn O. Blough and Herbert A. Smith, twelfth and thirteenth presidents, brought better balance to the work of NSTA by giving emphasis to science in the elementary school and to better programs for the education of science teachers. They also helped to establish closer relationships between NSTA and the growing list of government agencies interested in and giving support to science teaching.

To Doctors Donald G. Decker and Robert A. Rice, now controlling the destinies of NSTA, we offer congratulations and best wishes. They have inherited a tradition and the fruits of pioneering effort which will continue to flourish under their leadership. Our bridge is destined to span, not only national lanes, but those of the world through the expansion of our efforts in international activities.

Bridging the Future

The space age has brought new forces into being, difficult to understand and presenting difficulties of adjustment. Years ago, scientists and teaching scientists saw clearly that man need no longer crawl at the bottom of his ocean of air. Now the man on the street can see and understand that he is no longer earthbound. This fact, in time, will be as liberating in mind and spirit as was the discovery a thousand years ago that the earth is not flat. We now know how that simple discovery has changed civilization. Man's jump into the third dimension will have similar impact, only more quickly and dramatically. Man must suddenly adjust himself to such ideas as weightlessness, to a new order of speed of motion, to new kinds of radiation, to a new meaning of war, to strange new flights of imagination and adventure, to new concepts of life and living, and to powerful forces in the realm of ideas and the spirit which dwarf even the effects of the theory of evolution and of atomic energy. The future will not be smooth, but more challenging and zestful than any world man has ever known. In this future science teachers must play a leading part—a part which NSTA can make vitally important to build on for posterity.

Morris Meister leads us "across the bridge" into the future. A leader in education and a noted American "man" of Science, Dr. Meister is best known as founder and first principal of Bronx High School of Science. He was born in Poland, but has lived and worked in New York since coming to America with his parents. His undergraduate work was completed at City College, and he later attended Columbia University and New York University for graduate work.

THE FUTURE SCIENTISTS OF AMERICA FOUNDATION

By PHILIP G. JOHNSON

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IN the spring of 1951 The Thomas Alva Edison Foundation, Inc., gave support to a conference on scientific manpower that was planned cooperatively by the Foundation, The National Science Teachers Association, and the U. S. Office of Education. A follow-up conference was called by the U. S. Office of Education in the early fall of 1951 and proposals for action were becoming crystallized. The Committee on Professional Relations and Projects of the NSTA developed five successive drafts of plans for action. The basic ideas pertaining to services to future scientists and engineers were presented to the NSTA Board of Directors in January 1952 and an overwhelming vote for immediate announcement and action was received. A proposal for a Future Scientists of America Foundation was then prepared and presented to the Executive Committee of the NSTA and adopted by them in broad outline at a meeting in February 1952. Nineteen major associations, societies, government departments, and other agencies, all concerned about the manpower problems, were invited to send representatives for a full discussion of the proposal. Twenty leaders participated in the conference by asking penetrating questions, making suggestions, and giving words of caution. All were urged to discuss the proposed FSAF within their respective organizations and to send additional ideas for consideration. Needed revisions were made in the proposal before it was referred to the NSTA Board of Directors for study and action. Their vote in March 1952 approved further developments through the authorization of an Administrative Committee pro-tem to explore organizational and operational patterns and to report to the Board of Directors at the June 1952 meeting. The Administrative Committee pro-tem included representatives from the Atomic Energy Commission, National Council of Teachers of Mathematics, National Science Teachers Association, Secondary School Principals, Science Clubs of America, Science Service, and the U. S. Office of Education. Consultants and observers from other interested organizations and agencies also participated in the discussions. In the two meetings of the Administrative Committee pro-tem it became increasingly clear that (1) it would be wise to postpone the establishment of a youth organization since there were so many other services to be undertaken; (2) the Administrative Committee when established should be broadly representative of scientists, science teachers, and science educators; (3) there should be an annual meeting open to all concerned persons for purposes of learning about activities, presenting criticisms and making suggestions; and (4) the Future Scientists of America Foundation would be responsible to the NSTA Board of Directors. These ideas, with the proposed fields of action limited largely to Guidance and Related Services to Students, Science Achievement Awards for Students, Research in Science Teaching, Institutes and Workshops for Teachers, and Science Teacher Recognition Awards, were favored by the Board of Directors in their June 1952 approval of the establishment of an Administrative Committee for FSAF. NSTA now had a Future Scientists of America Foundation but no funds.

Two developments in the fall of 1952 helped the FSAF to get started. The American Society for Metals had supported a student achievement awards program and its operation was incorporated in the FSAF. A major chemical manufacturer volunteered to invite representatives from other major companies and foundations to a meeting where the FSAF plan could be presented, discussed, and plans for financing could be considered. This meeting brought out the need for research to determine what services were really important as an initial activity.

The critical shortage of scientists and engineers, together with the shortage of science teachers, made the area of guidance and related services a suitable area for research. What did science teachers know about the available science

incentives, science career information, and the specialized training opportunities for high school science students and high school science teachers? What did they know about science-related career materials and services for students? What were effective ways of using the available career materials and services? These and other questions were built into a research instrument which was distributed to science teachers with an appeal for a response based on their professional spirit and their desire to serve the youth and the Nation. Responses revealed that a vast majority of the teachers were unacquainted with many valuable career guidance materials and services. It was also clearly evident that there was no pamphlet to aid in the recruitment of future science teachers. The first published services of the FSAF were quite naturally a report of the research; a pamphlet giving specific titles, names and addresses for available materials and services; and a booklet on science teaching as a career. The booklet on career guidance materials and services has developed over the years through numerous revisions and is now available under the title of *Encouraging Future Scientists: Keys to Careers.* The booklet on science teaching as a career was reprinted numerous times and has now been completely rewritten. A corollary result outside of FSAF has been the preparation and publication of a large number of new and revised career guidance materials and the development of new career guidance services.

One of the urgent needs expressed from time to time by science teachers was positive help to students in initiating and developing science projects. Two pamphlets were prepared to help meet this need. One of these has recently been rewritten in order to render a more adequate service. They are currently available under the titles *Encouraging Future Scientists: Student Projects* and *If You Want To Do a Science Project.* During all the years of FSAF since its organization, there has been a Student Achievement Recognition Program sponsored with increasing generosity by the American Society for Metals. The design of the program has changed somewhat from year to year based on the suggestions of science teachers, but the basic pattern and plan have remained the same. Undoubtedly this has had a profound effect on the growth of science fairs and science congress activities. Along with this growth has come a growing number of criticisms about the national, state, and local promotion and operation of science fairs. Again and again the members of the Administrative Committee have considered these ideas, but due to the need for other services they have continued to postpone the establishment of a Future Scientists of America youth organization. What other needs and services have been given encouragement and help?

Special Projects

Science teachers were urging the FSAF to aid them in finding summer opportunities that were helpful in their teaching as well as remunerative in basic support. This resulted in vigorous efforts to encourage industrial research and development departments to employ science teachers and at the same time help science teachers to seek such employment. This program developed rapidly and within a few years the industries were managing their own campaigns to employ science teachers during the summer months. Science teachers were also asking for opportunities to participate in research at colleges and universities. FSAF sent inquiries to such institutions and thereby discovered where such summer opportunities would be available. Teachers were informed about these research participation opportunities and their applications were sent to the colleges and universities of their choice. Unfortunately the educational institutions found it difficult to provide the funds needed to compensate the teachers for their services and many teachers were denied opportunities of this kind. The values of this type of summer pursuit have recently been recognized by the National Science Foundation in an experimental program essentially like the one that FSAF initiated. More than 500 science and mathematics teachers were involved in this type of program during the summer of 1959 under stipends and allowances similar to the more common NSF Summer Institutes. Since this service has now been accepted as a major experiment by NSF the Administrative Committee decided to develop other needed services.

During the development of opportunities in industrial laboratories and in colleges and universities there were a number of critical problems that needed special study by science teachers. Such studies were made possible by grants of money to FSAF for the purpose of establishing and operating short summer institutes. Conference reports such as the following resulted from these conferences: Teacher Demonstrations in Chemistry, The Science Teacher as Career Counselor, Teaching Critical Thinking Through Chemistry, and Science in the Junior

High School. A program of recognition awards for teachers—another facet of the five major activies of FSAF, was made possible when the American Society for Metals approved the inclusion of teachers in the awards program. This continued for only a few years but the published result was *Science Teaching Ideas II* published in 1955. The most notable development resulting from FSAF explorations with awards for teachers followed when the U. S. National Cancer Institute provided NSTA with a grant to underwrite the STAR Awards Program. Three successive programs of Science Teacher Achievement Recognition have stimulated many teachers to make known their best teaching ideas.

U. S. Registry

All of you have been the beneficiaries of another service initiated by FSAF. Several years ago there was an evident need for a name list of science teachers of the nation. There was no such registry. FSAF appealed for funds but none was made available. Then FSAF began the task little by little from funds that had been contributed to FSAF without restrictions. When this list had grown to about 40,000 and when the NSF was enlarging its services to high school teachers the opportunity came. The NSF made available a generous grant to complete the name list of high school science teachers as well as the high school mathematics teachers—the latter with the cooperation of the National Council for Teachers of Mathematics. Again the FSAF pioneered and was ready to make use of its know-how in performing a needed service.

During these years when the FSAF was becoming established and undertaking services desired by science teachers the members of the Administrative Committee and other leaders concerned about science teaching as a profession, were searching for the major services under FSAF that might very largely overarch the development of pamphlets and reports. This type of searching became more and more the concern of the members of the Administrative Committee of FSAF as the National Science Foundation was making it possible for colleges and universities to develop and operate special summer and academic year institutes for science teachers. What major opportunities and services to science teachers and science students were still lacking? Considerable thought and counsel were devoted to a consideration of tests to identify science talents at an early age. This did not seem necessary in view of what was known about how such talents can best be identified and it was therefore not undertaken. A challenge to a few leaders in science teaching during a conference in 1954 brought forth an idea that has grown into a truly major idea, called On-the-Job Research.

It seemed to be the time to develop a design, to announce the plan to secondary school science teachers, and to see the types of proposals that would come forth. The Administrative Committee set aside $5000 for the first series of grants to be made in the fall of 1957. The plan that was developed in a committee meeting brought 16 proposals. Four grants were made for a total of $2600. A few additional proposals were considered in the spring of 1958 and the following fall. Three new grants were made and all the earlier grants were continued, some without any additional funds. Considerably less than a total of $5000 was allocated.

The sub-committee at the fall 1958 meeting gave much time to the planning of an evaluation. The evaluation was carried through and FSAF had reports of the pilot run of projects that had had time sufficient to get established and in operation. What appeared to be the verdict? Funds were very limited and little publicity was given to this pilot run. Therefore the basic factors of prestige, recognition, opportunity for increased income, reduced teaching load, and summer employment, had not been achieved. It appeared that intellectually stimulating associations have been achieved at least in part through work with the very capable students and consultations with the scientists. It appeared that the scientists were favorably impressed with the values of the projects, most of the school administrators welcomed the idea, and their school boards allowed their teachers to receive a grant which was administered by the office according to the prepared budget. Secondary school science teachers could and would submit worthwhile research proposals and would be challenged even if only modest grants for supplies, equipment, a few references, and a little travel were offered. It was clear that the effect on teaching was highly desirable and the safeguards that have been established were both desirable and rather adequate. The high school students thought very well of the idea and so did the community in places where they came to know about it.

On-the-Job Research by secondary school science teachers can have a truly great influence for good if FSAF will find available funds and if it manages effectively a substantial program of

Born in Nebraska and receiving his Master's Degree from the University of Nebraska, Dr. Johnson completed his Doctorate at Cornell University in Ithaca, New York, from which institution he now operates. Active in every phase of NSTA's professional services, Dr. Johnson represents one of our most tireless leaders and participants. His activities as author, teacher, administrator, and first President of NSTA, 1944-46, guarantee him a continuing esteem as a "founding father," and as a dean of American science education.

grants. There should be $250,000 available for grants within a school year. The Future Scientists of America Foundation could then announce to the secondary school science teachers of the Nation a program of grants that would make available to a teacher who can submit a truly promising proposal, enough money to provide *real* prestige and recognition; *real* opportunity for increased income for work after school, evenings, Saturdays, vacations, and the summer period; *real* reduced teaching load through money for the employment of a substitute teacher or part-time teacher to take over some of the regular teacher's work; *real* interesting and remunerative summer employment at home or in a nearby college or university; and young as well as mature persons who become intellectually stimulating associates. In the future there should be enough funds so that the scientific consultant will go to the school to meet with the students on the project as well as other students in the school and to tell the story of science and the lives of scientists, without any personal sacrifice and if possible with some honorarium. There should be enough funds for the purchase of the scientific supplies and equipment needed, the special references that are pertinent, and funds so that the teacher can travel to see the consultant as well as attend the principal meeting of the society most closely related to his area of research. How much would such a grant require? The amount will vary from project to project based on what the teacher and the school would propose but grants may well vary from $1000 to perhaps as much as $5000. FSAF will need a special executive to manage this program, plus the usual office staff. There will be a need for funds to bring together scientists and science teachers to study project proposals and to select those which appear to be truly promising. There will need to be some funds for office supplies, publicity, evaluation, and reports. It is hoped that there are corporations, foundations, and other agencies that will set an example in generous grants for others to follow. FSAF is ready to undergird our excellent secondary school science teachers so that they will continue to be leaders in our secondary schools, and our youth now in high school and in college will look forward to becoming outstanding secondary school science teachers because it appears to be a challenging and rewarding career. On-the-Job Research may become one of the major overarching services of FSAF in the future.

The members of the Administrative Committee have over several years studied the need for a Future Scientists of America youth organization. The great majority of science teachers and the leaders in science teaching feel that the present over-promotion of science fairs without much regard for the needs and wishes of the science teachers makes it wise to establish a competing organization to those already available since constructive competition has been the basis for progress in America. Plans are still rather indefinite but teachers are urged to send suggestions to the FSAF. A Future Scientists of America with the characteristics of a scientific organization could give new stature to the science activities of our youth. Here may be another of the major overarching services of FSAF.

And what of the future? The FSAF has had a busy and constructive past. You can be sure that it will have an even more active and constructive future. With your suggestions and criticisms it cannot help but grow.

Business-Industry Activities

By G. P. O'CONNELL

Public Relations Staff, General Motors Corporation, Detroit, Michigan

PIONEERS have been noted for their willingness to venture into the unknown—to go places and do things that other people have wanted to do. The true pioneer must have—an inquiring mind, a sense of adventure, and a desire to improve. The men and women who organized the National Science Teachers Association were truly pioneers.

The improvement of science education in the classrooms of the nation has always been considered as a major objective of the NSTA. During its fifteen-year history, NSTA has initiated a number of successful projects aimed at furthering this objective. One of these was the establishment in 1947 of a *National Advisory Council on Industry-Science Teaching Relations* made up of ten industrial representatives and ten science educators from various states.

The first few sessions of the Council were devoted to establishing a mutual understanding of the problems of science education and exploring ways and means in which the members, working together, could help solve these problems.

The need expressed by science teachers for supplementary teaching aids for use in their classrooms and laboratories, together with the willingness on the part of industry to cooperate by making available to science teachers much needed technical information, training materials, and equipment, set the stage for the Council's first project—the *NSTA Packet Service.*

To date 400,000 packets, each containing 6 to 10 items, have been distributed to science teachers throughout the country. Packets now go to 14,000 science teachers quarterly. These materials which include booklets, pamphlets, charts, etc., supplied by business and industry, provide teachers with up-to-date and realistic data and illustrations dramatizing scientific principles.

With the Packet Service well under way, the Council next addressed itself to the task of developing a program that would meet the broader aspects of all areas of mutual concern to science education and industry. This resulted in the development of its famous five-point program which came to be known as *CEDUR*—(See page 298).

The steady growth and development of NSTA's business-industry relations can be largely traced to the influence of the Advisory Council and its CEDUR program.

Perhaps the most significant development in NSTA's business-industry relations which came about as a direct result of the Council's activities was the formation in 1949 of a *Business-Industry Section in NSTA.*

When in 1950 the Board of Directors of the National Science Teachers Association approved the organization of the *B-I* group as a Section and accepted by-laws to govern its operation, it established the first, and to date the only, formal recognition of a relationship between business and industry and a department of the National Education Association.

In the pursuit of its objectives—advancing industry-education relations, furthering sound educational standards, and providing up-to-date information to teachers and students in a science oriented society—the B-I Section has grown over the years to its current membership of 290. Its membership is nationwide and is truly a cross section of a forward thinking business and industrial citizenry whose common bond is a sincere and active interest in the scientific education of our nation's youth.

The program of the B-I Section is mainly directed toward keeping the members up-to-date on current activities in the field of business-industry-education developments. This is accomplished primarily through news letters and other publications, surveys, meetings, and personal contacts.

The following are typical of the ideas and information that have been exchanged through these media:

advice on setting up and carrying out special projects of mutual interest to science education and industry, such as plant tours, conferences, B-I-E days, and science fairs.

suggestions on how to secure the most effective use of industrial information and materials prepared for schools.

reports on successful projects which have been carried on cooperatively by industry and education to keep classroom instruction up-to-date and vital.

methods for evaluating the success of a company's educational relations program.

Although the principal efforts of the Section are directed toward science education, B-I members on occasion have worked with other departments of the National Education Association as well as with other educational associations and groups. Through this cooperation, the Section has helped develop programs and materials in such subject areas as the social studies, home economics, and career counseling.

For the past several years during NSTA's Annual Convention the B-I Section has sponsored a luncheon at which a prominent industrialist is the speaker. Everyone attending the Convention is invited. The most recent addition to the luncheon program was the presentation of the *Annual B-I Award* which is given to an industrial concern or business for its outstanding contribution to the advancement of science education during the previous year.

In addition to the B-I Section's programs at the national level, chapters have been formed in New York City, Washington, D.C., and Pittsburgh. The members carry on their own local programs, hold meetings, exchange experiences, consult with educators in their areas, and help one another solve mutual problems.

During the past fifteen years, a number of business and industrial concerns have actively cooperated with NSTA in many of its activities such as the *Future Scientists of America Foundation, Summer Conferences for Science Teachers,* and the *Science Achievement Awards for Students.*

It is interesting to note how, over the years, the close working relationship which has developed between business and industry and the NSTA has led both groups to take an even broader interest in each other's problems.

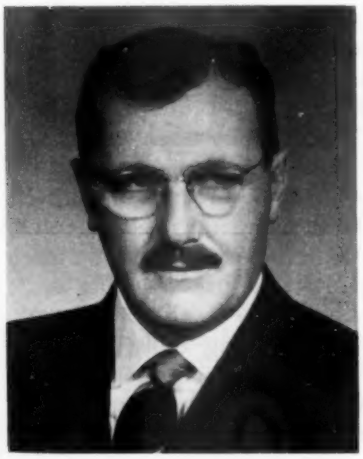
Business and industrial leaders have become more aware of the vital role education plays, not only in scientific progress, but in the over-all welfare of our country as well. They have become more cognizant of the serious problems which face educators today. They have had the opportunity to witness firsthand how educators are striving to overcome the difficulties imposed upon both teacher and student by such things as spiraling enrollments, double sessions, lack of trained teachers, and inadequate facilities.

So, too, more and more educators are becoming aware of some of the problems that face business and industry. They have found that many are similar in nature to their own. As a result, both are eager to find more and better ways to work together for both acceleration and cooperation in solving these problems.

We are committed to an era of progress, and have but one choice of direction—forward. This progress is not limited to the field of scientific investigation, of course, but the importance of this area is such that, in large measure, it will shape the nature of progress in all fields.

The National Science Teachers Association represents a teacher group which, more than any other single body in this country, will be responsible for a high level of science education.

The Business-Industry Section, as an integral part of NSTA, will continue to share in that responsibility by helping teachers in every way possible to do an even better job of presenting scientific knowledge and understanding to the young people of America, upon whose shoulders will rest the future well-being of all.



Educated in his native state (Dayton), Ohio, and continuing his education at the Universities of Detroit and Notre Dame, Mr. O'Connell has since been devoting his efforts toward education and public relations programs. His public relations work in these areas has included many specialized programs of business-industry and education.

Author, professor, and consultant, Dr. Blough is noted as a specialist in elementary science education. He is well known for his textbooks for primary and intermediate grades, and in addition has written numerous books for teachers, trade books for children, and magazine articles on science education. He graduated from the University of Michigan, continued graduate work at the University of Chicago, and was awarded an honorary Doctor of Laws Degree from the Central Michigan College of Education for his outstanding work in education.

The Elementary School Science Program

By GLENN O. BLOUGH

Professor of Education, University of Maryland, College Park

ANY forward-looking organization keeps attuned to the new problems faced by its members and attempts to give assistance in seeking solutions to these problems. Without question, the National Science Teachers Association has been aware of needs in elementary science teaching, and has contributed to growth and development of science in the elementary school throughout its history.

For many years there has been a building up of emphasis on science for elementary school pupils. Since World War II, and especially since the launching of the first Sputnik, new emphasis has produced an urgency to improve science at the elementary school level. Everywhere elementary teachers are being required to add science or increase the emphasis on science in their current programs. They are being expected to improve the quality as well as the quantity. Supervisors and principals are being asked to give more assistance to teachers. Curriculum makers are working on guides and courses of study. Superintendents are urging better programs. Parents and other lay groups are joining in these demands. These needs have resulted in activity on the part of many organizations whose function it is to help with the improvement of the science program and the teaching of such a program. Our Association has assumed leadership in this field and has, through several avenues which we shall discuss, been effective in assisting educators with their problems.

Publications Program

In one of the early planning sessions to increase the emphasis on elementary science, action was prompted from a statement that something practical was needed for the purpose of improving classroom teaching. This resulted in a decision to publish the *Elementary School Science Bulletin* of NSTA.

Since its modest beginning when ESSB was but four pages in size, written by a few interested persons, and published six times a year, it has grown to eight pages issued eight times a year, and its present production involves the work of scores of teachers, principals, supervisors, and central office personnel. Teachers and others find it useful in (1) keeping them up-to-date in science by the articles on current science content; (2) showing them concrete examples of teaching procedures; (3) helping them learn how to construct and use teaching aids; (4) keeping them up-to-date on the new books, visual aids, and other learning tools; and (5) inspiring them to do more science work with children at all levels of the elementary school. This publication reaches 30,000 subscribers.

The Science Teacher, the professional journal of NSTA, carries in every issue along with other content at least one or two articles directed to the elementary level of teaching. The articles include practical pieces on how to teach, informative material describing in-service activities, inspirational articles intended to show the importance of science as it relates to the total elementary school curriculum, and science subject matter articles to build informational background. New books, visual aids, and other teaching materials are reviewed each month and many of the general articles are appropriate for the elementary school teacher. Elementary schools are finding the journal a valuable asset to their libraries. This special edition, together with the history content, has the representative features of the normal 64-page publication which is issued eight times a year from September through May (excluding the month of January).

Other NSTA publications also include materials and methods for elementary applications. In 1951 the Association obtained the publication rights to a series of practical booklets written by Guy V. Bruce.[1] This series presents experiments and experiences useful in teaching various topics in the elementary school and are especially useful in the later elementary and junior high school grades. More than seventy thousand copies have been purchased and used by elementary and junior high school teachers.

A widely-used helpful publication is *A Bibliography of Reference Books for Elementary Science* by George S. Mallinson and Jacqueline V. Buck (50¢). This is a selected list of books other than texts, useful in elementary science, grouped according to grade level and science areas, or subject matter.

Conferences and Conventions

The National Convention and regional conferences of the Association have each year given increased attention to elementary school science through elementary supervisors' conferences, talks, demonstration lessons, group discussions, seminars, and "Here's How I Do It" sessions (the latter devoted to specific successful teaching procedures). These sessions have attracted educators interested in elementary school science in large numbers. In many instances the results have later been used locally by attending members to stimulate better teaching and to improve the program. Through these avenues hundreds of interested persons have been served.

[1] See Item 3 on page 316, "Science Teaching Today."

In addition to the conferences held in connection with annual and regional meetings, in the spring of 1958 the Association held a special conference dealing with selected, critical problems in the field of elementary science. A grant from the National Science Foundation made the conference possible and the report, ***It's Time for Better Elementary School Science*** (published by the Association) has been widely distributed and is still available (Item 2, page 316).

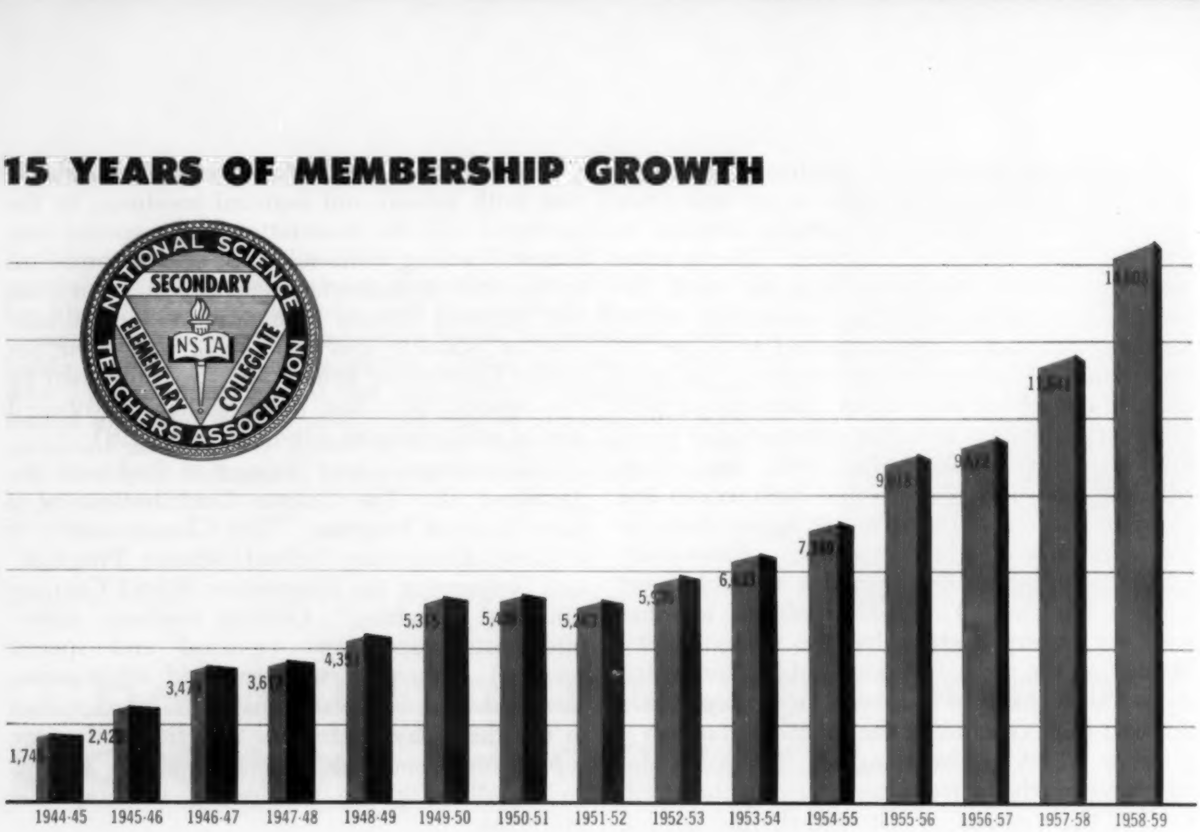
The conference was planned to deal with the problems of: "The Unique Contributions of a Good Science Program," "The Characteristics of a Good Elementary School Science Program," and "Improving the Elementary School Curriculum and Teaching." College teachers, superintendents, supervisors (general and special science), principals, teachers, and other interested persons, by special invitation participated in the three-day conference and the conference report represents the concerted efforts of this well-qualified group in dealing with specific problems.

Summary

The Association has accepted many invitations to cooperate with other national organizations in providing assistance with elementary science teaching problems, and it continues to do so. NSTA has cooperated with NEA Department of Elementary School Principals in its annual conventions by providing consultants and speakers and in deciding what issues and problems are urgent for consideration, and has assisted on a number of publications dealing with elementary science. Similar cooperation has been given to other units of the National Education Association.

Briefly, then, these are samples of the Association's accomplishments in the area of elementary science. Current plans are to continue these and similar services and to expand them as necessity arises and funds and personnel are available. The Association subscribes to the philosophy that one way to lift the level of accomplishments in the total area of science instruction is to pay more attention to the early experiences which pupils have in the field of science. The more interested children become in science, the more satisfactory their science-learning experiences are and the better the total science program becomes. It is not necessary to wait until a child reaches high school to learn science. However, there is plenty of reason to believe that a firm foundation is essential to a strong twelve-year program.

15 YEARS OF MEMBERSHIP GROWTH



NOTE—Of the above totals approximately 500 foreign members from 46 countries are represented.

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THE NATIONAL SCIENCE TEACHERS ASSOCIATION

The National Education Association's department for science teachers at all grade levels and in all fields of science

MEMBERSHIP APPLICATION FORM—complete and mail to

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- ☐ Renewal
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FIELD OF INTEREST
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- ☐ Elementary science
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*Please also indicate ONE subject matter field.

Applications for individual memberships must be accompanied by payment. Please make checks payable to NSTA.

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NOTE: PLEASE BE SURE TO INCLUDE ZONE WHERE USED.

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Membership Secretary
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Check which ONE of the following publications you want FREE OF CHARGE. Check any TWO publications if you enroll as a Life or Sustaining member.

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- ☐ Experiments With Radioactivity. 1958. 20p. — .50

NOTE—Of the annual membership dues, $3 is for year's subscription to THE SCIENCE TEACHER. Single subscriptions for TST not available.

PLEASE DO NOT WRITE IN SPACES BELOW.

54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73

Beyond This Issue Toward Infinity

By DONALD G. DECKER

President of NSTA; Colorado State College, Greeley

ALL predictions of the future will some day be lost in the realities of the present. Whether realities were once predictions is of little consequence to those who must cope with them. But inasmuch as thoughtful concern for the future may permeate current thinking and action with a quality and purpose they would not otherwise have, the hazardous task of writing such an article at the risk of being thought presumptuous becomes emotionally palatable.

Reviews of the past are a popular vehicle for riding into the future. Analysis of the present is a common intellectual endeavor for mentally taking a sabbatical from the present and visiting the land of "what-might-be if-trends-continue." The musty archive or the formalized statistical approach to answer the questions beloved of educators—where should we be going, and what guidelines should we be developing?—is, to say the least, time-consuming.

I prefer the Consequence Method, the "if-we-don't, what-will-happen" approach to the future. The archive or statistical methods do not yield predictions that result in the emotional overtones and immediate action that the Consequence Method stimulates.

You are now quite aware of the theme of this essay and my reasons for selecting it. My purpose in describing this procedure for contemplating the future derives from the fact that I am a recently elected voice-of-the-future participant in this NSTA Anniversary Issue of *TST*, and am quite aware that any one of a number of other members could have thought and written about the future much more provocatively.

The NSTA has 15 years of experience as an organization dedicated basically to the improvement of science education in the United States. A maturing process has occurred during these years that now makes it possible to plan efficiently for an effective future, to complement a distinguished past. This is the task of the present that looms before us.

Some time in the future the aims and purposes now stated need to be carefully and specifically defined and organized into a practical work-directive pattern. For example, one of the current statements of aims is to improve the professional competency of science teachers. This is not a work-directive aim until we answer the question—What characteristics does a professionally competent teacher possess? Until this is done, we cannot be of help to administrators who are analyzing teacher records to determine competency prior to employment; we cannot be of service to ourselves in increasing the quality of membership in our organization by admitting on the basis of professional competency, nor can we reply to those who seek our advice concerning our definition of a competent science teacher.

The achievement of a work-directive definition of aims is half the task. The other half is organizing the current list of aims and purposes so that staff, committees, budget, and publications have a specific place in carrying forward the work of the Association. Without such organization, we may unwittingly devote much time, energy, and money to the achievement of a few purposes and neglect many others. A simple organization I would suggest for the future has three parts:

This year's President, Dr. Donald G. Decker, is Dean of the College, Colorado State College in Greeley. Long an active member of NSTA, he also participates in the Colorado Education Association, being one of their past presidents; and in other educational and scientific ventures. He is an author of textbooks for elementary school science and has been a consulting editor in the preparation of numerous science teaching films and filmstrips. His undergraduate work was at Eastern Michigan College with graduate work at Colorado State College. He received his Doctorate at Columbia University.

I. Science Education Activities for Youth;
II. Professional Activities for Teachers;
III. Association Activities for Members.

Each aim and purpose of the Association can be classified under one of these three activities, as can the functions of committees, the budget, staff, and our publications. Without such an organization, we cannot analyze our current or future endeavor to discover to what extent we are supporting one of these fundamental areas and perhaps neglecting another.

To carry out the directives of a program as defined above, serious consideration must be given to the requirements for such a program. Fundamentally, no program is workable if confined to a narrow and highly stratified limit of funds and personnel. The essentials for the growth or improvement of any program are dependent on these two ingredients. The recipe for professional and wholesome growth must therefore not only include the proper measures of these ingredients, but they must also be available in sufficient quantity.

In the formative years of an organization, the recipe must needs be a resifting and remixing process before the final ingredients for success are found. In examining the activities of the past years, it now appears opportune to re-examine the ingredients, sift and mix, and produce the service our members have a right to expect.

As a beginning, the Association is requested to examine again the three activities outlined above.

The key to our continued growth on all fronts depends upon the continuation of the programs begun, and expansion into new areas to meet the needs of our members. This includes or certainly implies more vigorous effort to develop and strengthen state organizations of science teachers in the working relationships between these state units and the national associations.

The first consideration therefore is to produce a plan to provide a more flexible budget for operation of the program, and to relate the proceeds of this budget directly to the functions under the three activities or goals for the future. Under this plan, the Association can channel the efforts of its Board of Directors, committees, and staff toward a definitive result, and will be able to forge ahead to meet new demands. Such a plan will enable a more efficient and practical use of personnel and materials. In addition, the operations of the Association become less complicated to report and lead to better direction.

One example for more effective control and direction lies in the operation of our committees. The present structure is diverse, and it is suggested that standing committees be established to encourage, suggest, and review in each of the three areas of activities. One committee would be concerned with the science education activities of NSTA for youth; one would do the same for the professional activities of NSTA for teachers; and one would function in the same manner for the Association activities of NSTA for its members. The total program of NSTA then becomes evaluated and directed by its members. The Board of Directors would therefore have available three reports and recommendations from three committees for the following year. The chairmen of these committees should be on call for the Executive Committee whenever new ideas are to be presented for consideration. New proposals will first be judged in consideration of their fitness for the purposes of NSTA and the

plans of the committee whose responsibility they would become if accepted.

Future activities of this kind could well change portions of convention planning. The members of NSTA, as a body gathered to direct the affairs of the Association, would accept the responsibility to hear, discuss, and help direct the work of each of these basic committees. The future strength of NSTA depends, to some degree, on the extent to which the membership-at-large becomes interested and involved in the work of the organization. In the future, the motive for attending conventions should be two-fold instead of one-fold: (1) To come to get professional help and exchange ideas, and (2) to take an active part in the work of the Association. Without such a two-fold motive an organization cannot be as effective as it might be, for it needs the best thinking of its entire membership rather than delegating the work and thinking to a few.

The next suggestion gives one pause and perchance to dream and to say, "If I should live so long, this I would like to see." A standing committee should be appointed to work out plans for the international activity of NSTA. Surely we are remiss in our responsibilities if we confine our efforts in the 20th century to continental United States. As an organization we should be reporting to our members what is happening in science education all over the world. We should be meeting and exchanging ideas with teachers in other countries. We should be as international as science is and as successful in uniting to solve educational problems as was the scientific work that took place during the IGY.

For example, in discussing this topic one evening with our Executive Secretary, he suggested that the NEA Travel Division might organize a science education tour to survey possibilities of international activities. Just as a beginning, in the future, a regional meeting in Canada and planning for a "summit meeting" in London could spearhead our approach to cooperating throughout the world for the improvement of science education through NSTA.

Conduct of the future is not our immediate responsibility, but reflecting on the future to improve the present is. Perhaps the time is now for the serious discussion of making ideas such as these realities, and the many more that others can contribute. Why don't *you* write about them?

Yes, all predictions of the future will some day be lost in the realities of the present. Whether realities were once predictions is of little consequence to those who must cope with them. But inasmuch as thoughtful concern for the future may permeate current thinking and action with a quality and purpose they would not otherwise have, I put down my pen in the hope I will not be judged presumptuous for what I have written.

***Note:* These possibilities for further activities of NSTA were discussed at the Annual Board Meeting for 1959 in St. Louis, Missouri. Board actions will appear in later issues of TST.**

THE MEMBERS REPORT:

What NSTA Means to Me

OTIS W. ALLEN

Leflore County Schools, Greenwood, Mississippi

The first time I heard "NSTA" it meant nothing. Then I attended a regional conference of the National Science Teachers Association and started the most meaningful relationship of my professional life.

About ten feet within the conference room on the left side was a display of membership literature and an attractive young lady who explained that NSTA is the National Science Teachers Association. Her name was Mary and in less than ten minutes she had my ten-dollar payment on a life membership.

Almost ten years from that event I have enjoyed many aspects of NSTA and feel that no science teacher should deprive himself of this fellowship with a nation of outstanding science teachers.

The program of NSTA helped me improve my efforts in the classroom. "You'll never walk alone" through a course in biology, chemistry, or physics even though you are the only science teacher in the school. The companionship of NSTA brings new ways with every publication, meeting, and conferences, both regional and national.

I like *The Science Teacher*. The feature articles are by able science teachers and scientists. They have helped me bring many boys and girls into interest, understanding, and appreciation of science. As the pages of *The Science Teacher* fly by I even enjoy the advertising. I've always recognized that much science can be done with spools and strings, soda and vinegar, and by other simple, common devices, and materials; yet I know the exact science of any learning situation starts when students work with accurate, easily operating, time-saving equipment. *The Science Teacher* ads have introduced some of the best equipment, books, and services to help me in my teaching.

The Future Scientists of America Awards showed me some outstanding work from the classrooms in my region. For two years of the FSA Achievement contests, a panel of five college and high school science teachers spent several hours with me selecting the winners from many entries. All who entered the contests certainly grew in science as they prepared their entries, and some of these young students became literal scientific giants in the work they had achieved through research and reporting, thanks to NSTA and the sponsors of FSA. To me they mean we should not undersell our youth. My students can always do more than I have awakened in them.

NSTA added meaning to my affiliation with the American Association for the Advancement of Science, the National Educational Association, and other scientific and educational organizations. A big team of organizations is doing much to interpret science for teachers, parents, and students, and NSTA has helped me to assume my responsibilities and more effectively render a service by interpreting science to teachers, students, civic clubs, and the friends I meet on the street or across the table.

Many elementary teachers have asked for assistance. They desire more science for their inquiring pupils. I have taught in the elementary grades and recognize their problems and visualize the possibilities of improving kindergarten and elementary teaching with a proper program of science. To achieve these ends is not difficult. *The Elementary School Science Bulletin* is published by NSTA to help elementary teachers and I always like to see the ESSB available to them. I feel the influence of NSTA every time I visit a good program of science in an elementary school and see the ESSB among the teaching aids.

Tomorrow's Scientists for the secondary students helps me bring an exchange of scientific ideas between my students and those who contribute the articles. Expanding these contacts so more students will participate, offers a medium for national student exchange of ideas, collections, and projects. Studies of the geographical distribution of plants and animals in time and space such as exchange letters on a North-South direction for students to establish the dates for bird migrations, plant growth, weather studies, astronomical observations, and others can function through *Tomorrow's Scientists*.

I like the Packet Service of NSTA. This treasure of scientific and industrial information has meant value to thousands in my schools. By passing the packets around, all our students have the benefits of the free and inexpensive materials. There's a new idea for someone in every packet; and the materials are very current.

I wish you could have been with me on some NSTA committee meetings or with the NSTA Board of Directors. These are the hardest working friends I have ever met. It means a lot to accept a job for NSTA with good science teachers from throughout the nation working on an important problem of great value to science education. Helping solve these problems is stimulating, but meeting the best people on earth and adding them to my list of friends is the "life of Riley" in the science teaching world.

My year with the Ford Foundation studying science programs in the schools and trying to determine ways for us to prepare personnel for the science industries helped me to see that the science teacher is highly regarded by people in places of high rank and responsibility. I am further convinced that NSTA speaking for all science teachers can mean more than the sum total of all our individual efforts.

The National Convention of NSTA is the "greatest show on earth." I was so impressed by the first National Convention in Pittsburgh, Pennsylvania, that I have spent over one thousand dollars of my own money and traveled several thousand miles by car, bus, train, and plane to attend all of the conventions of NSTA. It means a lot to me to be a member of the fine program committee for the 1960 National Convention of NSTA in Kansas City, and it will mean much more if I can see you there for the great program of science from K through 12 grades. I have attended all the general sessions, all the banquets, business and industry luncheons, and visited every commercial exhibit; also all the sectional meetings and "Here's How I Do It" sessions that time would permit. With this sample of NSTA, I feel very closely and warmly with and for its efforts and recommend and invite you to its active membership. Frankly, I believe you'll enjoy the life membership because of its wide service and the feeling of permanent belonging that is associated with it.

Now another young lady speaks for NSTA. This time it is Frances, our Associate Editor, who invited this article. Naturally, she could have selected many who could have written better but she would not have selected anyone *who gets more from NSTA*.

What NSTA Means to Me

EUGENE ROBERTS

Polytechnic High School, San Francisco, California

1. Primarily, NSTA is the national organization of my professional field of science teaching, and it is a pleasure to be a member of an active organization which is providing aggressive leadership.

2. I appreciate the representation, however remote it may be, which NSTA gives me as a classroom teacher. When I recognize NSTA members that appear on a nationally televised United States Steel Hour to explain to the public the pressing need for science teachers, when I hastily thumb through the preliminary listings of the Physical Science Study Committee and note that NSTA officials are included, when I read of testimony given before Congressional committees by our group, I see myself as having some say in the problems, programs, and legislation which may eventually affect me in the classroom. True, none of my ideas is expressed, as such, in this remote representation, but in a review of the editorials in *The Science Teacher*, NSTA's journal, I am apprised of the thinking and philosophy of those who, in elective or executive positions, represent NSTA. Should I differ, I may voice this personally for clarification, or officially to the members by publication. Thus, through NSTA it is possible for me, as a member, to reach people who have the *entree* which, as a classroom teacher, is not ordinarily mine.

3. NSTA provides valuable contacts far beyond the realm of my own classroom. The Packet Service material, which may or may not be useful to me immediately, provides me with a sampling of some of the best items available, as well as a source list for possible future use.

4. NSTA activities are geared to the classroom level. Its *Tomorrow's Scientists* publication was tested by classroom teachers prior to its launching as a regular publication, and classroom teachers serve as its field editors. The NSTA publication list is directed principally to the classroom teacher and is crowded with specific aids in specific areas. The professional journal publication, *The Science Teacher*, ably spreads its attention among the various subject fields and grade levels, and covers broad fields of professional interest, as well as specific classroom techniques. In addition, the awards program of the Future Scientists of America gives the students of every classroom science teacher an opportunity for recognition regardless of the isolation of their school.

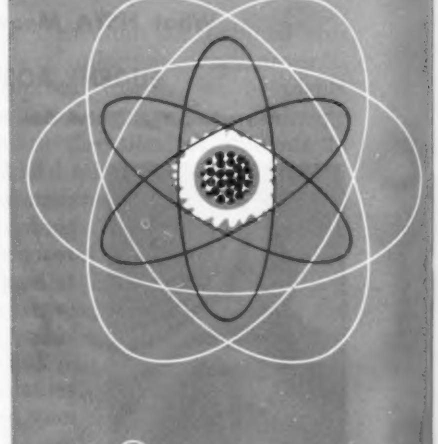
5. I favor the continuous and positive efforts of NSTA to raise the professional status of the classroom science teacher. Through the recognition given in the STAR awards, through the effort to encourage industry to employ science teachers in summer science-related jobs, through the summer research assistantships, through the recognition given to local science teacher organizations, through its cooperation with other scientific and technical organizations, and through its own committee organization (the authoritative publications *School Facilities for Science Instruction*, and *Let's Build Quality into our Science Tests* are two examples, each the result of extensive committee work), NSTA pursues a positive program to enhance the position of the classroom teacher of science.

6. NSTA provides a professional experience which many of us might never have had without its annual sponsorship of three or four regional meetings throughout the country in addition to its always "bigger than ever before" annual convention. It is only a question of time before almost every part of the country has one of these "Replica Conventions." We've already had two in California.

7. As a member of NSTA I have a feeling of being "in" on the activities which are important to science teachers. Take the National Science Foundation Institutes, for instance. When they were first initiated the only information I ever obtained about them came from NSTA's *The Science Teacher*. I know that as a member of NSTA I will receive the necessary information of these institutes as well as other professional opportunities as a part of the routine operation of NSTA.

8. Finally, there is the almost monthly arrival of *The Science Teacher* to draw my attention beyond the confines of my classroom to what might be called "the big picture" in science education. Every issue may not provide me with material of immediate interest, but a file of those issues over the years builds a reference shelf which can be very helpful. This was demonstrated to me during an in-service course at a local college when the topic of workbooks came up. Half of the references listed in the Educational Index were from *The Science Teacher* and were thus available to me in my own home. Although I eagerly look through each issue for items of immediate use, lately I find the "over-view" articles assuming more and more significance for me. In a year's time I'd guess that there would be something for every one. I've even found *The Science Teacher* helpful in keeping up in my own field of physical science (witness the careful analysis, in depth, of Newton's Laws just this past year), and in developments in science teaching in general. I wouldn't want to be without my regular copies of *The Science Teacher*—after all, that's my business and profession in life, being a science teacher, and NSTA is my major line of communication with my profession.

In a simple sentence—NSTA means a lot to me as a classroom teacher of science, and I am happy to be a Life Member!



The SYNTHETIC Chemical Elements

By GLENN T. SEABORG

Professor of Chemistry, Lawrence Radiation Laboratory, University of California, Berkeley

DURING the 18th century about a dozen chemical elements were discovered and the atomic theory of matter was born. About sixty more elements were identified in the 19th century, and in the same period Dmitri Mendeleev, the great Russian chemist, brought order out of the chaos of the elements, giving us, at the same time, the tremendous power of predicting the properties of undiscovered elements.

By the middle thirties, man, who examined the composition of the rocks, minerals, atmosphere, and oceans of the earth and even the sun, had discovered 88 elements. Four—elements with atomic numbers 43, 61, 85, and 87—remained below element 92. And beyond 92 lay the unknown.

Scientists by this time were not at a complete loss to explain what had happened to the four missing elements and the unknowns beyond 92. It could be shown that these elements were radioactive, with such short half lives that their existence in appreciable concentrations on earth is not likely. The creation and identification of these elements in the laboratory was to require a vast amount of toil, ingenuity, and luck—in sum, a remarkable chapter in man's ancient effort to satisfy his curiosity. When we look back from our vantage point today, and survey the remarkable discoveries that lay ahead of scientists in the middle thirties, we cannot help but experience a thrill in the feeling that today's unknown is just as rich. And this thought makes us impatient to forge on to new prizes of knowledge.

The discovery and earliest chemical studies of the synthetic elements were accomplished by the tracer technique, with submicroscopic, unweighable amounts of the materials. The subsequent production of larger quantities of the elements has permitted more detailed investigations. All of the synthetic elements have either been isolated in weighable quantities or have isotopes of sufficiently long half life to permit their isolation with the exception of elements 85, 87, and those with atomic numbers greater than 99.

Transuranium Group

Of the synthetic elements, the most important and the most well known is plutonium. With this element, modern workers obtained a substance infinitely more valuable than the gold so desired by their medieval predecessors, the alchemists.

There is much of interest about the element aside from its nuclear properties. The chemistry and metallurgy of plutonium are exceedingly intricate and unusual and both have been investigated very thoroughly. As for its physiological properties, plutonium (as Pu^{239}) is one of the most dangerous poisons known to man. The high alpha radioactivity (about 140,000,000 alpha disintegrations per minute per milligram) of the isotope and its chemical properties, which cause it to lodge in the bone after assimilation, are the causes of its toxicity. Special equipment and precautions are requisite for the investigation of its properties, and small amounts are usually used in experiments but large amounts are available.

Progress in the study of the transuranium elements was greatly facilitated by the discovery in 1944 of their proper place in the periodic table

of the elements. The known transuranium elements have been found to be members of a group of chemically similar elements, the actinide transition series, which begins with actinium (element 89) and includes thorium, protactinium, uranium, and the transuranium elements through the undiscovered element 103. The concept that the

FIGURE 1. Periodic table of the elements. The synthetic elements are circled.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac-(103)	(104)	(105)	(106)	(107)	(108)	(109)	(110)	(111)	(112)	(113)	(114)	(115)	(116)	(117)	(118)

Lanthanides	La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Actinides	Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	E	Fm	Mv	102	103

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heaviest known elements are actinides has led to their placement in the periodic table as shown in Figure 1. This entailed removing thorium, protactinium, and uranium from the positions they had occupied for some years as the homologues of hafnium, tantalum, and tungsten, respectively, and assigning them to their proper places as shown in Figure 1. A close chemical resemblance exists between the actinide series and the lanthanide series (which begins with lanthanum, element 57 and ends with lutetium, element 71) and the members of each group correspond in chemical behavior. Thus the chemical homologue of americium is europium; that of curium, gadolinium; etc.

So far this article has contained quite general information on the synthetic elements, but one might wonder exactly how these transmutation experiments are planned and carried out. The story of the discovery of mendelevium is a good example to select as it involved procedures and techniques which will perhaps be applied in the production and identification of other elements.

The plan was to bombard einsteinium (element 99) with helium ions (element 2) to produce element 101 $(99+2)$, and the amount of the new element that we expected to prepare was calculated as follows. The number of atoms of mendelevium, N, prepared in each bombardment should be approximately calculated as follows: $N \cong N' \sigma It$, where N′ is the number of einsteinium atoms used as a target; σ, the cross section or probability for the reaction; I, the intensity of the helium ion beam; and t, the effective time of the bombardment. The cross section for the reaction was predicted to be about 10^{-27} square centimeters on the basis of known values for previously observed similar reactions. Only about 10^9 atoms of einsteinium, in the form of the isotope E^{253}, which had been prepared by the neutron irradiation of plutonium, were available as target material. The intensity of the helium ion beam was 10^{14} particles per second per square centimeter. Predictions indicated a half life of the order of hours for the expected isotopes, so a value for t of 10^4 seconds was used. Substituting these numbers in the equation, the calculation was made as follows:

$$N \cong (10^9)(10^{-27})(10^{14})(10^4) \cong \text{one atom per experiment.}$$

Thus under optimum conditions, the preparation of only about one atom of mendelevium per experiment could be expected! This was the first time that the detection of transmutation products produced by the charged particle bombardment of an invisible amount of material had been attempted in any experiment.

Identification

The preparation and identification of element 101 was successfully accomplished although the initial prediction of the reaction yield was correct. The most formidable task was devising a method to separate the one atom of the new element from the target material. How this was

DR. GLENN T. SEABORG, Nobel Prize Laureate, author, chancellor and associate director of Lawrence Radiation Laboratory, began as an instructor at the University of California in 1939. With his associates through 1941, he discovered about 12 isotopes which led to the discovery of plutonium. Prior to this work, he earned his Ph.D. in Chemistry, following the completion of his undergraduate courses at UCLA.

Of Swedish ancestry, he is a native of Michigan but moved to California about 1922, and attended David Starr Jordan High School, 1925-29.

In 1942, through 1946, on leave from the University, he worked at the Metallurgical Laboratory in Chicago to head the section on transuranium elements research, particularly plutonium. He has published about 180 papers and a number of books on nuclear science.

done is indicated schematically in Figure 2. The helium ion projectiles, or alpha particles (1), were sent through the back of the target (2). The target consisted of einsteinium plated on a gold foil as a very thin layer. Transmuted atoms, recoiling due to the momentum of the helium ions, were caught on a second gold foil (3). This second foil was dissolved (4) and the chemical separations performed beginning with this solution.

The next step (5) was the separation of element 101 by the ion exchange adsorption and elution technique and its identification partly by its elution order. Such separations by ion exchange can be performed as follows. The solid ion exchange resin is stirred into an aqueous solution containing tripositive ions of actinide elements, which replace the exchangeable cations of the resin. The solid resin is then usually placed at the top of a glass column filled with untreated resin. A solution containing anions (the eluant) which forms complex ions with the adsorbed elements is poured through the column to effect their removal. The drops of eluant are collected and analyzed by means of their radioactivity. Solutions of chloride, nitrate, lactate, citrate, or alpha hydroxyisobutyrate ions, for example, can be used as eluants. In certain systems the actinide and lanthanide elements are eluted in the inverse order of their atomic numbers, as is indicated in Figure 2. Thus, element 101 would leave the column first, followed by element 100, then element 99, etc.

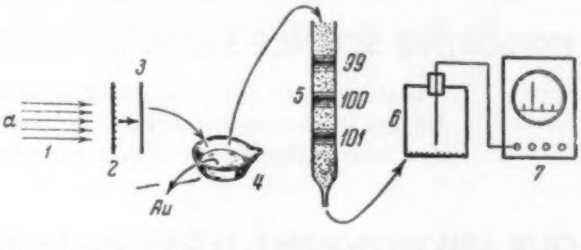


FIGURE 2. Schematic representation of the steps in the discovery of mendelevium (element 101). The figure was reproduced from the Russian journal "Priroda."

The ion exchange adsorption and elution technique is one of the most valuable tools we have for separating and identifying transuranium elements. Unlike most conventional chemical sepa-

ration methods, it offers the necessary selectivity and rapidity. Lanthanide elements can also be separated by this means and the analogy between the ion exchange behavior of actinide and lanthanide elements has provided the basis for initial identification of most transuranium elements.

Returning now to the discovery of element 101, the drops leaving the column were analyzed with respect to their radioactivity as is indicated by (6) and (7) in the Figure 2. The chemical identification of the new element involved the combined products from three successive bombardments in which a total of five spontaneous fission counts and hence five atoms were observed in the element 101 elution position. The isotope discovered has the mass number 256 and decays by electron capture to the isotope Fm^{256} which is responsible for the spontaneous fission decay. Subsequent experiments using larger amounts of einsteinium in the target have led to the production of hundreds of atoms of element 101.

Table 1. The Synthetic Elements

Atomic Number	*Name*	*Discoverers and Date of Discovery*	*Source of First Preparation*	*First Isolation in Weighable Amount*
43	Technetium	E. Segrè and C. Perrier. 1937	bombardment of molybdenum with deuterons.	1947. Tc^{99}(2.12 x 10^5 y). In 1947 simultaneously by G. E. Boyd, Q. V. Larson, and E. E. Motta, and G. W. Parker, J. Reed, and J. W. Ruch.
61	Promethium	J. A. Marinsky, L. E. Glendenin, and C. D. Coryell. 1945	found as a fission product of uranium.	1948. Pm^{147}(2.6 y). G. W. Parker and P. M. Lantz.
85	Astatine	D. R. Corson, K. R. MacKenzie, and E. Segrè. 1940	bombardment of bismuth with helium ions.	
87	Francium	M. Perey. 1939	found as a radioactive decay product of the naturally occurring element actinium.	
Transuranium Elements:				
93	Neptunium	E. M. McMillan and P. H. Abelson. 1940	irradiation of uranium with neutrons.	1944. Np^{237}(2.2 x 10^6 y). L. B. Magnusson and T J. LaChapelle.
94	Plutonium	G. T. Seaborg, E. M. McMillan, J. W. Kennedy, and A. C. Wahl. 1940	bombardment of uranium with deuterons.	1942. Pu^{239}(24,360 y). B. B. Cunningham and L. B. Werner.
95	Americium	G. T. Seaborg, R. A. James, L. O. Morgan, and A. Ghiorso. 1944-45	irradiation of plutonium with neutrons.	1945. Am^{241}(458 y). B. B. Cunningham.
96	Curium	G. T. Seaborg, R. A. James, and A. Ghiorso. 1944	bombardment of plutonium with helium ions.	1947. Cm^{242}(19 y). L. B. Werner and I. Perlman.
97	Berkelium	S. G. Thompson, A. Ghiorso, and G. T. Seaborg. 1949	bombardment of americium with helium ions.	1958. Bk^{249}(7 x 10^3 y). S. G. Thompson and B. B. Cunningham.
98	Californium	S. G. Thompson, K. Street, Jr., A. Ghiorso, and G. T. Seaborg. 1950	bombardment of curium with helium ions.	1958. $Cf^{249-252}$. B. B. Cunningham and S. G. Thompson.
99	Einsteinium	A. Ghiorso et al. 1952	in first thermonuclear explosion.	
100	Fermium	A. Ghiorso et al. 1952	in first thermonuclear explosion.	
101	Mendelevium	A. Ghiorso, B. G. Harvey, G. R. Choppin, S. G. Thompson, and G. T. Seaborg. 1955	bombardment of einsteinium with helium ions.	
102	Not yet named	A. Ghiorso, T. Sikkeland, J. R. Walton, and G. T. Seaborg. 1958	bombardment of curium with carbon ions.	

(y = years)

Predictions

The discovery of new transuranium elements and isotopes is a continuing goal, and there is much work related to this subject currently in progress both in the United States and abroad. Many of the techniques which have been evolved are applicable to the investigation of new elements, but their separation from target material and identification offer formidable problems owing to the expected short half lives. Unfortunately, for the prospect of producing even higher elements, predictions based on the radioactive decay properties of known transuranium elements suggest shorter and shorter half lives as the atomic number increases. By the time elements 104 and 105 are reached, we shall probably find that the longest-lived isotopes that can be made will exist barely long enough for chemical identification. In the case of element 104, the predicted half lives of the longest-lived isotopes are measured in seconds or minutes and for element 105, in seconds. Isotopes containing an odd number of neutrons or an odd number of protons or an odd number of both neutrons and protons offer the most promise for the investigation of the properties of these very heavy elements because they are expected to decay more slowly than isotopes containing an even number of protons and neutrons.

The prediction of the chemical properties of the elements beyond mendelevium seems to be quite straightforward. The position in the periodic table of undiscovered elements up to element 118 can be predicted as a consequence of having determined the point of filling of the 5f electron shell which occurs at element 103, even though many of them will never be produced. The chemical properties of all of these elements can be estimated to the same extent that membership of any element in a certain group of column in the periodic table foretells its chemical properties (see Figure 1). Thus element 104 should resemble hafnium; 105, tantalum; 106, tungsten; etc.

Synthesis by heavy ion bombardments offers the most promise for the production of elements of high atomic number. Isotopes of californium, einsteinium, and fermium have been produced by the bombardment of uranium with carbon, nitrogen, and oxygen ions, respectively, and element 102 was discovered as a product of the bombardment of curium with carbon ions. These heavy ions can be accelerated in cyclotrons of the conventional type, but specially designed cyclotrons and linear accelerators which will be devoted to the acceleration of heavy ions to energies sufficient to transmute the heaviest nuclei are also coming into operation in several laboratories throughout the world. Even with the use of heavy ions, the lack of availability of target materials of high atomic number and the extremely small reaction yields present very serious problems for the researcher.

One might ask why we wish to prepare and study substances with such fleeting existences, especially since this requires the solution of many difficult problems. The answer is that we hope to learn more about atomic and nuclear structure. We can never forsee what new facts we may find but I am certain that the unknown of today is just as rich in prizes as that of yesterday.

Bibliography

G. T. Seaborg and E. G. Valens. *Elements of the Universe*. E. P. Dutton and Company, New York. 1958.

G. T. Seaborg. *The Transuranium Elements*. Yale University Press. 1958.

S. Glasstone. *Sourcebook on Atomic Energy*. Second Edition. D. Van Nostrand Company, Inc. 1958.

THE SCIENCE ACHIEVEMENT AWARDS

By FRANKLIN G. FISK

Science Education, University of Kansas, Lawrence

THIS fall marks the beginning of the ninth annual program of Science Achievement Awards for Students (SAAS). This nationwide program is supported financially by the American Society for Metals and is administered by the Future Scientists of America Foundation of the National Science Teachers Association.

The following article gives some detailed information on the SAAS and on the students and teachers involved in past programs. The information appearing in this article was obtained from a nationwide study of national and regional winners and honorable mention award winners in the first six years of the program's existence. In addition, the study also solicited information from the teachers who were sponsors of these award winning students. The study[1] was supported by NSTA's Future Scientists of America Foundation and was submitted by the author as a partial requirement for the Master of Science Degree at the University of Kansas. The study was under the direction of Dr. Herbert A. Smith of the University of Kansas, currently on leave to the U. S. Office of Education, as head of the project to administer Title III of the National Defense Education Act of 1958.

History and Growth of the SAAS Program

The SAAS program was initiated in the spring of 1952. Although organizational changes have been made in the program, its basic purposes have remained unaltered. The purposes of SAAS, as stated below, are a synthesis of the many statements appearing in *The Science Teacher* and in brochures announcing the program. These purposes are:

1. To stimulate and increase interest in science.
2. To stimulate and increase interest in science experimentation.
3. To encourage project work in science.
4. To increase science enrollments.
5. To help students choose scientific vocations.

[1] Science Achievement Awards for Students.

Participation in SAAS is open to any student in grades seven through twelve in the 50 states, U. S. territories, and Canada. Students enter the contest in certain levels for the regional awards. (The grade-level entrance requirement was cited by many science teachers as being one of the outstanding features of the program.) Students enter in one of the three following levels: grades 7-8, grades 9-10, and grades 11-12.

Currently there are 22 National Metals Awards, consisting of a 100-dollar U. S. savings bond, for projects entered which have as their main emphasis the study of metals or metallurgy. These projects are also eligible for regional awards. There are now 18 regional awards in each of the 11 regions (previously there were 15 regional awards in eight regions). The 18 regional awards are divided six to each grade level, with the awards being a 25-, 50-, and 75-dollar U. S. savings bond for the low, middle, and high grade levels in each region.

In addition to the above awards, each winner receives a gold FSA pin, a plaque for his school's trophy display, and an FSA certificate. About 40 to 50 per cent of all entrants are recognized with Honorable Mention certificates.

The program has had a phenomenal growth since its beginning in 1952, shown in the table on the next page.

It should be noted that the number of entries has increased every year, the increase being so great in some of the regions that for the 1959 program three of the regions were subdivided to give a total of eleven regions, thus increasing the number of regional awards from 120 to 198.

All projects entered in each region are judged by a committee appointed by the regional FSAF[2] chairman. This committee donates its services and makes the selection of regional winners and honorable mention awards. These are forwarded to NSTA headquarters in Washington, D. C.,

[2] Future Scientists of America Foundation.

along with all the metals projects where the issuance of all awards to the regional winners and honorable mentions is accomplished and the National Metals Award winners are selected.

The SAAS Evaluation Study

In this evaluation study, an attempt was made to contact every regional and national winner and their teacher-sponsors and a 10 per cent stratified random sample by year, grade, and geographical area, of the honorable mention students and their teacher-sponsors for the first six years of the SAAS program. An initial mailing to the schools of 408 lists of names of teachers and students to obtain correct addresses resulted in 400 returns in three months. This 98 per cent return was deemed a remarkable phenomenon in itself! The following table gives the number and percentage returns of the questionnaires for the students and teachers for which addresses were obtained.

	Received	*% Return*
National Metals Winners	31	82
Regional Winners	381	78
Honorable Mention	159	71
Teacher sponsors-winners	206	64
Teacher sponsors-honorable mention	88	61

It was assumed that a representative national and regional winner group was obtained while possibly a slightly biased group was obtained for the honorable mention students; biased to the extent that this group is probably more select than the over-all honorable mention group.

Some Characteristics of the Regioncl Winners and Honorable Mention Students

One of the aspects of the study was a comparison of the regional winners with the honorable mention students. Comparisons were made with regard to projects entered, educational background, future educational plans, parental educational and occupational status, and various extracurricular activities of a scientific and nonscientific nature. An intra-group comparison was also made for the winners on the number of winning awards received as an outcome of the number of times a student entered the contest. It was found that the regional winner and honorable mention students were very similar in many of the comparisons with the few exceptions as noted in a later paragraph.

Concerning science projects, approximately 44 per cent were in biological science, 40 per cent were in physical science, nine per cent were in

Number of Winners, Honorable Mention, and Entries in the SAAS Program by Year of Program

Year Program	*No. Nat'l Metal Winners*	*No. Regional Winners*	*No. Honorable Mention*	*No. Entries*	*% increase per year in No. Entries*
1952	0	16	22	450	0
1953	0	83	129	600	33
1954	0	100	365	953	59
1955	0	98	277	1300	36
1956	20	120	815	2040	57
1957	20	120	1191	2927	44
1958	20	120	1673	4158	42
1959	22	198	1773	4730	12

earth science, and five per cent were in mathematics. The remaining projects were not covered by the above categories. Eighty per cent of the science projects were prepared outside of class while 50 per cent received class credit. The median time spent on the project entered was from four to six months, while the median cost of the project was from six to nine dollars.

The parents of the students were very well educated and the mothers were not "working mothers." Fifty-six per cent of the fathers and 52 per cent of the mothers had been educated beyond the level represented by high school graduation. Approximately 12 per cent of the fathers had earned the doctorate degree. The fathers' occupation is in line with their rather high level of educational preparation, with 35 per cent in professional and 15 per cent in managerial occupations as classified by the *Dictionary of Occupational Titles*. One-half of the fathers classified in a professional occupation were engaged in scientific occupations.

The students plan to enter, or are already enrolled in college. From 70 to 80 per cent of the

winners and honorable mention students were planning to, or were already majoring in science or science-related fields of study in college. They were apparently a very select group in this respect. Among the various proposed and actual science majors, physics was the most common choice of regional winners and honorable mention students, although chemistry, electrical engineering, and medicine were given high rank. Science teaching as a career choice ranked low.

The students took a large number of science and mathematics courses in high school. They were very active in non-athletic types of extracurricular activities and, although these students were not social recluses, it should be noted that their interests were predominately in science and science-related activities which would tend to make their activities less social. Judging from the number of science and non-science awards received in school, the regional winners and honorable mention group were outstanding students.

It should be stated, however, that the winner and honorable mention groups of students did differ in several respects. Seventy-five per cent of the regional winners received one or more science awards outside the SAAS program, while only 55 per cent of the honorable mention students were in this category. It would appear that the winners might be more active in science contests and in science activities than the honorable mention students. Regarding offices held in science organizations, it was found that 60 per cent of the winners as against 28 per cent of the honorable mention students have held offices in high school science organizations. The same percentages also held for being president of high school organizations. Of the winner and honorable mention students who are now in college, 40 per cent of the winners and 20 per cent of the honorable mention students reported full-time scholarships.

Of the regional winners, five students won a regional award in three annual SAAS programs and 23 students won a regional award in two annual programs. Of the total number of regional awards available, 58 per cent were won by students receiving only a single regional award.

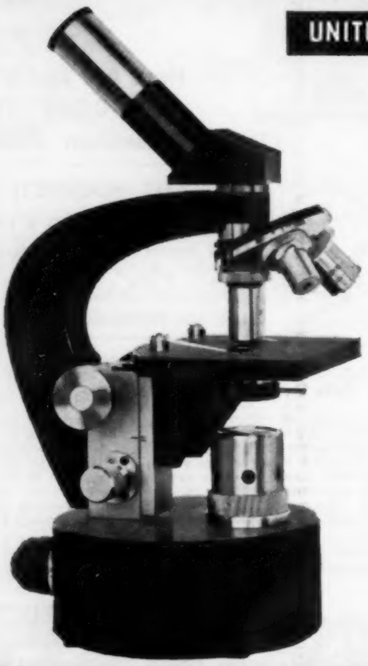
The Students' Sponsors

Each entrant in SAAS must have a teacher as a sponsor. The sponsor may or may not be the actual person directing the student's project, but it is assumed that this is the situation that exists

(Continued on page 350)

UNITRON student microscopes offer

UNITRON STUDENT AUTO-ILLUMINATION MICROSCOPE, MSA



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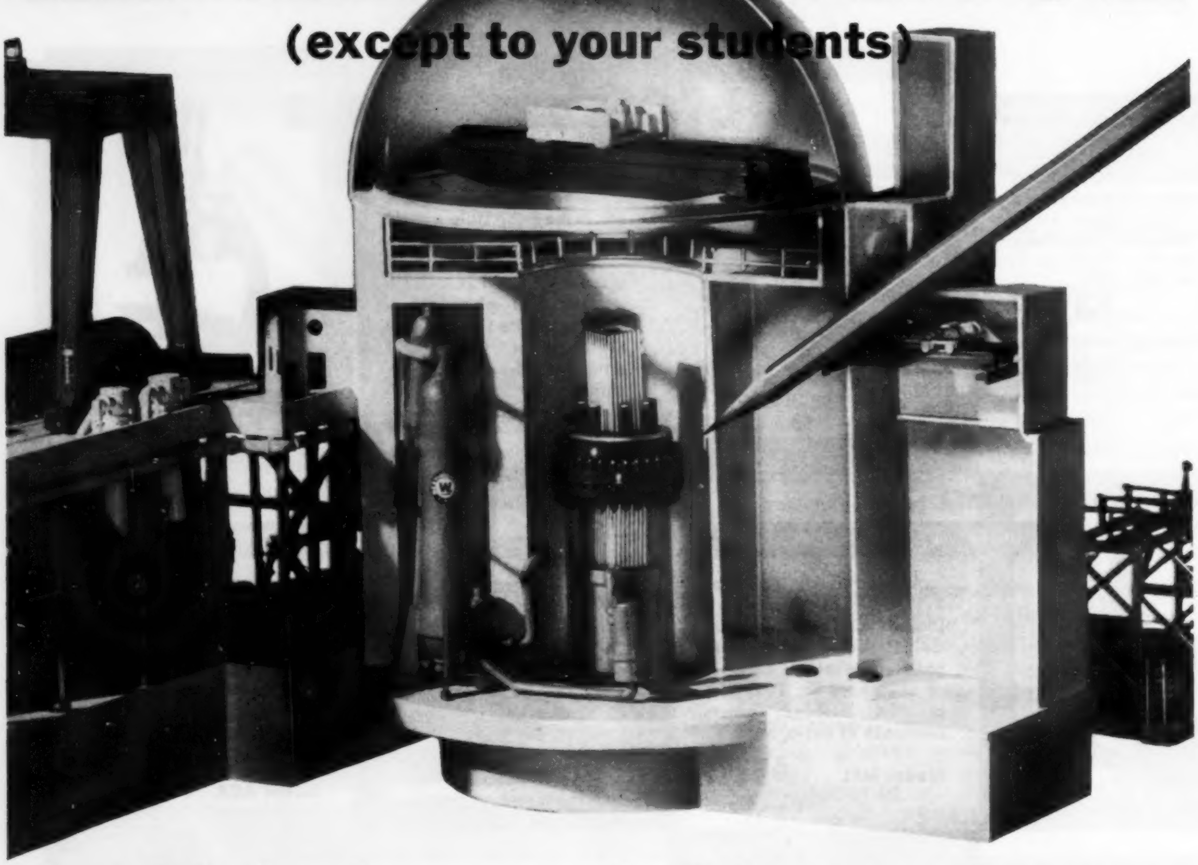

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Antibiotics from Your BACKYARD

By **ARTHUR J. BAKER**

Biology Teacher, Crystal Lake Community High School, Crystal Lake, Illinois

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

A UNIT on fungi was introduced by playing for my classes a record of a radio broadcast dating back to 1946. This recorded dramatization was entitled "The History of Penicillin."

All the classes showed interest in this project and stimulated enough response to begin some work. Student-teacher planning made possible the activities that are now briefly described.

Each class divided itself into six teams.

Team I, the mycologists: Their duty was to work with the mold cultures, extract mold from the soil, and grow these in pure culture.

Team II, the bacteriologists: They captured bacteria from the air and grew these stock cultures on slants so that we would have organisms on which to assay the mold inhibiting power.

Team III, the sterilizers: This team had the task of keeping Petri dishes, test tubes, Erlenmeyer flasks, and various other equipment sterilized and ready for use at the request of the mycologists and the bacteriologists.

Team IV, the assayers: Here rested the responsibility of actually testing the killing power of the mold on chance bacteria taken from the air.

Team V, the classifiers: This group attempted to classify the molds with a key from the text, *Bacteriology*, by Buchanan. The key was entitled, "The Key to the Orders, Families, and Genera of Common Molds."

Team VI, the sanitationists: This group was given the task of scouring and cleaning the glassware as it was used and re-used.

In addition, each student had the responsibility of bringing in a sample of soil taken from some location of a favorable mold environment, i.e., a moist soil near such material as a fertilizer bed, compost heap, or other likely locations.

We used for our agar media a dehydrated culture media purchased from Difco Lab, Detroit, Michigan. Mold was grown on potato dextrose agar and the bacteria on nutrient agar. Later, when the actual assays were made, we mixed equal parts of the two agars in the hope that we would get a more efficient growth of both the bacteria and mold on the same agar.

Our first duties were to prepare the bacteria and mold agar. The bacteriologists set about the task of trapping bacteria from the air and raising stock cultures while the mycologists began extracting mold spores from the various soil samples.

High school sophomores gather frozen soil from beneath a blanket of snow.

The technique of the latter was as follows. We placed one gram of the soil sample in a sterile Erlenmeyer flask and added 25 cc's of sterile water. One cc of the liquid, after being washed on the soil, was extracted by the aid of a sterile 1 mm pipette and deposited in the bottom of a sterile Petri dish over which was potato dextrose agar that had been melted and cooled to 44° C.

The Petri dishes were incubated for 36 hours. Confronting the students with the Petri dishes that they had set up was quite an interesting moment for the class. They were dubious. It was winter. "Could actual mold spores be extracted from the frozen soil?" We had used a dilution of 25 cc's of water to one gram of soil on the assumption that very few spores would be successfully extracted in such an environment. To our amazement, the Petri dishes proved to be literally covered with developing spores. It proved impossible to even attempt to extract a specific mold and grow it in a pure culture.

Research, then, was necessary to determine the proper dilution of water to make it possible to separate the spores so that pure mold cultures could be separated. We tried dilutions of 1-100, 1-200, 1-400, 1-600, 1-2000, 1-2400, and 1-4800. The dilution of 1-4800 provided an adequate environment in which the mold cultures could be nicely separated and transferred to sterile test tube slants, where the individual molds might grow in pure cultures. This procedure was followed with many of the soil samples.

It was now the assayer's task to test the inhibiting power of these molds on an unknown bacteria sample taken from the air. Sterile agar in an Erlenmeyer flask was melted and cooled down to 44° C. To this was innoculated a loop of living bacteria from one of the stock test tube slants. The flask was vibrated to diffuse the bacteria through the agar. The innoculated agar was then poured into sterile Petri dishes where it was allowed to jell. A tiny bit of the mold to be assayed was then deposited on the agar, the position of which approximated the center of the dish.

The classifiers, up to this time, had been drilling themselves in the use of the key. Once a mold with antibiotic properties was discovered, they played a more realistic role. It was then time for them to tell the class just what specific mold possessed the ability to inhibit growth.

The young assayers could not hide their anticipation when, after 36 hours incubation, it was time to examine the Petri dishes. One need only imagine the reaction when it was discovered that several of the Petri dishes showed a distinct "halo" of agar surrounding the mold.

Cultures of two of the molds along with photographic prints of the Petri dishes showing promi-

Photographic image of clear halo around a mold growth demonstrates that mold inhibits the bacteria with which its agar was seeded.

nent halos were sent to the Charles Pfizer laboratories for their comments.

Reports came back identifying the cultures as *aspergillus niger* and *mucor*. Dr. Weyer, of course, informed the class that both of these groups were well known with respect to their antibiotic properties.

This was no disappointment. The students were well aware of the remoteness of the possibility of making an original discovery. The pride of the mycologists, in having the laboratory confirm their classification of *aspergillus* was one of those rare, spontaneous demonstrations so characteristic of the enthusiastic adolescent.

Advantages of this project are listed below:

1. It develops an awareness of the variety and number of micro-biotic life in a gram of soil.
2. Distribution of responsibility in the class enabled all students to feel important.
3. The value of team work in a scientific research program was more fully appreciated and understood.
4. The classification of molds became a purposeful activity which students accepted eagerly rather than with reluctance.
5. This project revitalized interest in living organisms found out-of-doors at a time of year this opportunity is seldom experienced.

CONTINENTAL CLASSROOM

You may register for full credit at any of the following colleges:

ALABAMA: Spring Hill College, Mobile

ARIZONA: Arizona State College, Flagstaff

ARKANSAS: Arkansas A & M College, College Heights
Arkansas State College, State College

CALIFORNIA: Chapman College, Orange
Sacramento State College • San Diego State College

CONNECTICUT: New Britain State Teachers College
University of Hartford

GEORGIA: Valdosta State College

IDAHO: University of Idaho, Moscow

ILLINOIS: Greenville College
Mundelein College, Chicago • Northern Illinois University, DeKalb
Quincy College

INDIANA: Indiana State Teachers College, Terre Haute

IOWA: Clarke College, Dubuque
Iowa State University, Ames • Morningside College, Sioux City
State University of Iowa, Iowa City • Westmar College, LeMars

KANSAS: Kansas State Teachers College, Emporia
Washburn University of Topeka • McPherson College

KENTUCKY: Nazareth College, Louisville

MARYLAND: College of Notre Dame of Maryland, Baltimore
University of Maryland, College Park

MICHIGAN: Eastern Michigan College, Ypsilanti
University of Michigan, Ann Arbor • Wayne State University, Detroit

MINNESOTA: Bemidji State College

MISSISSIPPI: Delta State College, Cleveland
Tougaloo Southern Christian College

MISSOURI: Harris Teachers College, St. Louis

NEBRASKA: Kearney State Teachers College

NEW HAMPSHIRE: Plymouth Teachers College

NEW JERSEY: Montclair State College

NEW YORK: Yeshiva University
Agricultural & Technical Institute, Farmingdale
Marymount College, Tarrytown-on-the-Hudson
Niagara University • Albany State University College for Teachers

NORTH CAROLINA: Bennett College, Greensboro
East Carolina College, Greenville • Western Carolina College, Cullowhee

OHIO: College of St. Mary of the Springs, Columbus
Miami University, Oxford • Mount Union College, Alliance
Ohio State University, Columbus • Our Lady of Cincinnati College
University of Cincinnati • Ursuline College, Cleveland

OKLAHOMA: Oklahoma City University
Oklahoma State University, Stillwater • Phillips University, Enid

OREGON: Southern Oregon College, Ashland
University of Oregon, Eugene • University of Portland
Oregon State College, Corvallis

PENNSYLVANIA: King's College, Wilkes-Barre
Marywood College, Scranton • Temple University, Philadelphia
Villanova University

SOUTH CAROLINA: Furman University, Greenville
Limestone College, Gaffney

TENNESSEE: Middle Tennessee State College, Murfreesboro
George Peabody College for Teachers, Nashville

TEXAS: Austin College, Sherman
Howard Payne College, Brownwood • Texas Lutheran College, Sequin
Texas Technological College, Lubbock • The University of Texas, Austin

VIRGINIA: College of William and Mary, Norfolk
Richmond Professional Institute • Virginia Union University, Richmond

WASHINGTON: University of Washington, Seattle

WEST VIRGINIA: Concord College, Athens
West Virginia State College, Institute • Marshall College, Huntington

WISCONSIN: Beloit College

A textbook, entitled "Modern Chemistry," and a study guide have been especially written for this new course. Copies may be obtained through local bookstores or from Prentice-Hall Inc., Englewood Cliffs, N. J.

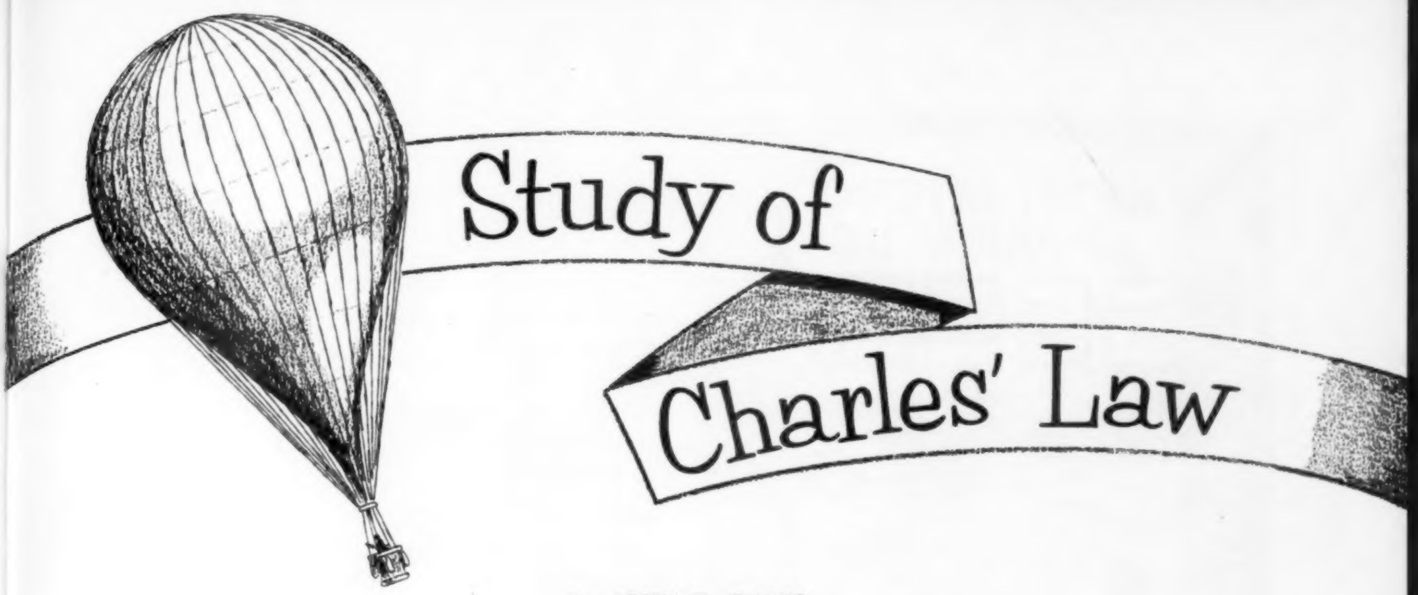
NSTA Elections for 1960

Now is the time and your opportunity to help select nominees for positions on the NSTA Board of Directors to be filled in the 1960 election. These positions include: president-elect for 1960-61 (to be president 1961-62) and secretary for 1960-62; also, directors for Regions II, IV, VI, and VIII. Directors also serve two-year terms.

Candidates for these offices will be chosen by the Election Committee, and election is by mail ballot of the membership-at-large. All offices, therefore, are national in scope even though geographical distribution is assured by Regions.

The Elections Committee will meet in Kansas City on October 16-17, and your suggestions for potential nominees should be sent to the chairman not later than *October 10.* Chairman of this year's committee is Dr. Kenneth E. Anderson of the University of Kansas, Lawrence. Other members of the committee will be announced in the October issue of *TST*.

In submitting names, please also send the following information: present position, address, NSTA position for which recommended, and brief summary of nominee's education, activities, and professional interests or related activities.



Study of Charles' Law

By JOHN D. DAVIS

Science Teacher, Exeter High School, Exeter, New Hampshire

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

MANY introductory experiments designed for the high school chemistry laboratory, although accurate, are overly simplified and give little regard to sustained interest. This exercise is designed to answer partially the need for more demanding experiments. It demonstrates the actual operation of Charles' Law and demands accuracy and concentration not often required in regular high school laboratory work.

The exercise was developed with certain purposes in mind: 1. The experiment gives experience in the handling of complicated apparatus. Charles' Law can be demonstrated by a less detailed method than the one used here. Such a method, however, offers little opportunity for either achieving accurate results or coping with some of the more painstaking aspects of scientific investigation; 2. The student encounters many manipulative problems in constructing and operating the apparatus. Here, in addition to achieving accuracy, the student must check and re-check to keep every part functioning properly; 3. The student must meet exacting standards of measurement typical of actual research. Measurements must be taken and recorded quickly; 4. The student becomes aware of the many variables that must be controlled in an experiment; 5. The student acquires a working knowledge of Charles' Law by computing theoretical results. Each student within a group should make the same computations, and check results to eliminate errors.

Description of the Experiment

The experiment is designed to show the relationship, known as Charles' Law, between a gas volume and temperature. This law states that the volume of a gas changes by 1/273 of its volume at 0° Centigrade for every degree change in temperature, if the pressure remains constant. If the temperature increases, the volume will increase; if the temperature decreases, the volume will decrease. Using V_1 and T_1 for the original volume and temperature respectively, and V_2 and T_2 for the resulting volume and temperature, the formula expressing the relationship is:

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}.$$

The derivation used here is:

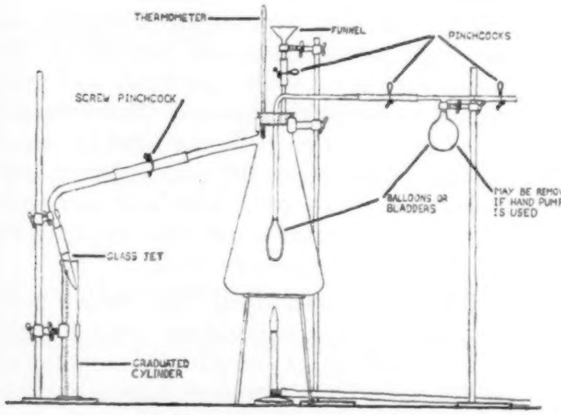
$$V_2 = \frac{V_1 T_2}{T_1}.$$

The experiment consists of four parts: a. The balloon is placed in the water-filled flask and inflated to a satisfactory volume. Then the water is heated over the desired temperature range. The combined expansion of the balloon and the water is measured by recording the amount of water in the graduated cylinder at every degree change. The apparatus is then allowed to cool; b. The balloon is replaced by a solid object having the same volume as the initial air volume. Again the water is heated over the same temperature range. The water in the cylinder is

recorded. This amount represents only the expansion of water. When these figures are subtracted from the related values obtained in the first part of the experiment, the results show the increase in the volume of the balloon; c. As soon as the initial volume is known, the theoretical increase in volume can be computed. This procedure will be discussed later; d. The predicted and actual results are then plotted on a graph and compared. The average variation between the two results is computed, and the percentage of inaccuracy is determined.

Assembling the Apparatus

The following materials are needed: three ring stands, Pyrex flask—preferably a vacuum filter flask of at least two-liter capacity, tripod, wire gauze with asbestos, two balloons or bladders, one large rubber stopper with necessary holes, funnel, thermometer, three spring pinchcocks, one screw pinchcock, five clamps, Bunsen burner, small rubber stoppers (for part two), glass jet, graduated cylinder, large glass jar (for storing extra boiled water), glass and rubber tubing.



APPARATUS FOR DEMONSTRATION OF CHARLES' LAW

The assembled apparatus is shown in the diagram illustrated. The external balloon assures smooth, even inflation of the internal balloon or bladder. The external balloon is inflated first, and then air, controlled by the pinchcock, is allowed slowly into the inside balloon. Initial inflation can be either by mouth or hand pump.

The apparatus should be assembled very carefully. The bulb should be the only part of the thermometer projecting below the stopper. Further insertion can cause inaccurate readings. Care should be taken to locate the balloon so that no part of it touches the sides of the flask. The lead-in tube from the funnel should not project

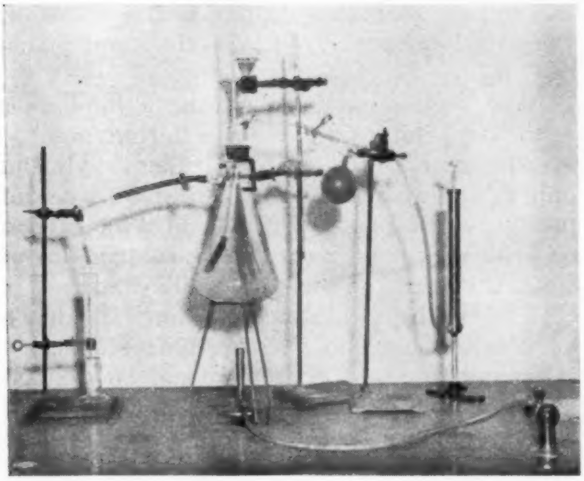


Figure 1. Apparatus assembled for heating of air sample.

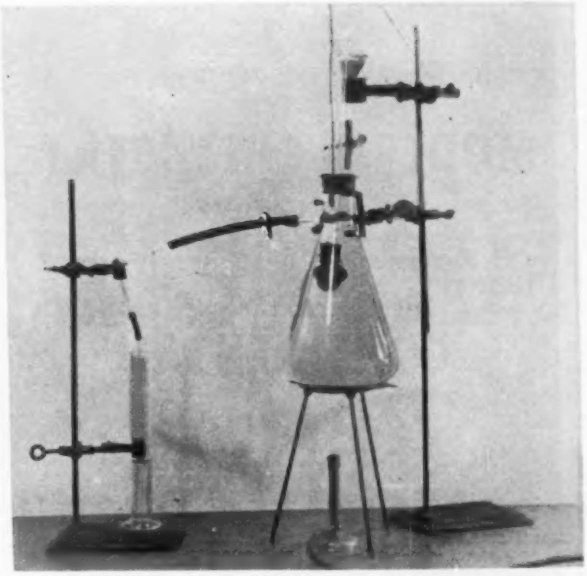


Figure 2. Solid rubber stoppers have replaced the balloon.

below the stopper. Proper positioning of this tube sometimes makes it possible to remove trapped air bubbles by passing them up the funnel tube.

Note the screw pinchcock is placed on the rubber tube leading to the graduated cylinder. This pinchcock is left open while the apparatus is operating. The others are closed.

The size of the opening in the glass jet can be determined by the operator. It must be small enough to prevent air from passing upward through the tube and yet large enough to prevent resistance from slowing the rate of discharge. Fasten the graduated cylinder to avoid upsetting.

For part two the balloon is replaced by a solid object having the same volume as the initial volume of the balloon. Rubber stoppers are suggested as solid objects. If the tube that held the balloon is not removed, its inner end must be blocked. It is perhaps easier to replace this tube with one of solid glass.

Operational Procedure

(1) In the preliminary work all water used in the flask must be boiled to remove dissolved gases. Subsequently, prolonged contact with air should be avoided. Water prepared in this fashion should be siphoned from one container to another.

(2) Fill the flask with the prepared water and insert the stopper with the thermometer, tubing, and *deflated* balloon mounted on it. Press the stopper down taking care not to trap bubbles beneath it. Continue to exert pressure and open the pinchcock leading to the funnel until the water level has risen into the funnel. Then shut off this pinchcock and fill the funnel with water. Again open the same pinchcock and open the screw pinchcock allowing some water to pass out

through the jet into a waiting beaker. Shut off the funnel pinchcock, but leave the screw pinchcock open.

(3) Check to see that the water in the flask is at the temperature desired as a starting point.

(4) Inflate the balloon or bladder slowly and only to the extent the air will still have constant pressure as it expands. The volume of the balloon or bladder will be recorded by the amount of water that runs into the graduated cylinder.

(5) Now begin heating. Readings should be taken from the cylinder for every degree change in temperature, and heating should be stopped a considerable distance short of 100° C to avoid boiling. (Figure 1)

(6) When the water has cooled to the starting temperature, proceed to the second part of the experiment. The procedure is identical except that a solid object equal in volume to the initial air sample is substituted for the balloon. The flask is then heated over the same temperature range and the volume of water discharged is recorded for every degree change in a cylinder. (See Figures 1 and 2.)

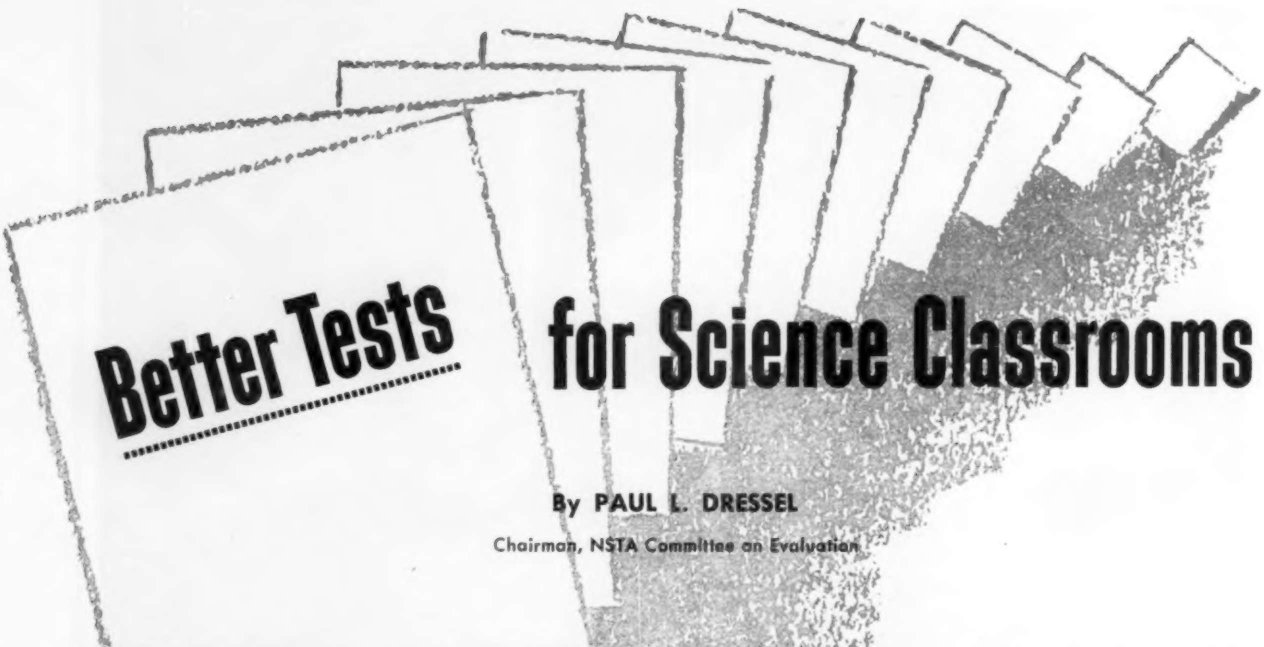
(7) As soon as the initial volume of the air sample is determined, figuring of the predicted expansion can start. As stated in Charles' Law the increase will be 1/273 of the volume at 0° C. Thus, the increase will be constant and a straight-line graph will develop.

The degree of accuracy that can be obtained is greatly dependent upon the care and thought that go into the experiment. In one case a group of students achieved results showing an average deviation from the predicted results for a volume of 12 ml of only 0.0937 ml. Such results are unusual. Yet all of the results were acceptable.

Analysis of Results

In order that the students might compare among themselves, a percentage of inaccuracy was computed. First, the average variation between actual and predicted results was figured using the variation found at five-degree intervals. This average variation is then divided by the original volume of air in the balloon, thus giving a percentage of inaccuracy.

At the conclusion of the experiment the results were brought together in a group discussion. Results of different groups were compared. Computations for the per cent of inaccuracy were carried out. Variations in the procedure were considered. Questions were asked about the procedures and precautions that were observed.



Better Tests for Science Classrooms

By PAUL L. DRESSEL

Chairman, NSTA Committee on Evaluation

THE Committee on Evaluation of the National Science Teachers Association has undertaken a study* in recent months to survey the standardized tests available for use in science classrooms. It had two purposes in mind: (1) to study the weaknesses and strengths of existing tests, and (2) to determine the need for additional tests in particular areas so that the committee members might recommend the writing and publication of such tests for wide distribution.

The Committee's first conclusion was that most available standardized tests in the science area are chiefly designed to measure achievement, with the greater number of items attempting to measure a student's retention of specific facts rather than his ability to analyze a problem, propose hypotheses, and work out a solution.

If teachers teach for such objectives as understanding of science theories, the structure of science, problem solving, the ability to reason logically, and the ability to apply what is learned to new situations, most of the standardized tests now available tell them little about the extent to which these objectives are being realized. Evaluation instruments for these objectives must be made by teachers themselves until such time as better standardized tests are available.

A second conclusion of the Committee was that there is a dearth of tests, especially of well-constructed and well-validated ones. Though no member of the Committee would assert that he had located and reviewed all tests in his particular field, extensive correspondence was carried on in an effort to locate all tests which are readily available and which are accompanied by some standardization data on at least one group. These tests are very briefly reviewed on the following pages. One member of the Committee, Professor Gebhart, was particularly interested in conservation, but was unable to locate tests in this area.

Brief Reviews of Available Science Tests

The reviews which follow are limited to the name and publisher of the test, a brief description, and an over-all evaluation. More detailed reviews of some of these tests are to be found in Buros' *Mental Measurement Yearbook*. Analyses[1] of these tests have also been prepared by the Committee for publication by NSTA.

BIOLOGY TESTS[2]

ACHIEVEMENT EXAMINATIONS FOR SECONDARY SCHOOLS: BIOLOGY, by B. R. Whittinger. C. A. Gregory Co., 345 Calhoun St., Cincinnati, Ohio. Copyright, 1954. One form, 4. For high school students, end-of-course in biology. Not machine scorable. Time 1½ hours.

* A report of the Committee on Evaluation of the National Science Teachers Association: Ned E. Bingham, University of Florida; John G. Read, Boston University; James W. Gebhart, Montana State University; Vernon C. Lingren, University of Pittsburgh; Walter E. Hauswald, Sycamore High School, Sycamore, Illinois; and Paul L. Dressel, *Chairman*, Michigan State University.

[1] *Analyses of Science Tests*. National Science Teachers Association Committee on Evaluation. 1959. 50¢.

[2] List compiled and tests reviewed by Ned E. Bingham, Professor of Education, University of Florida, Gainesville.

Measures understanding of biological principles and concepts, not mere knowledge of facts. Questions carefully worded; covers a variety of topics. Whether it covers the most frequently taught topics is not known, since no information is given about how topics were selected.

Achievement Examinations for Secondary Schools: Biology, by B. R. Whittinger. Educational Test Bureau, Educational Publishers, Inc., Minneapolis. Copyright, Form 2, 1952; Form 3, 1953. Two forms, each with 9 parts. No grade level given. Test not included in 1958 catalog. No manual of directions or norms available. No information about scoring. Time: Form 2, 1 hour; form 3, 1½ hours.

The purpose seems to be to measure acquisition of biological facts. Very little attempt to measure ability to apply knowledge in new situations or to measure understanding of relationships between bits of information was noted. However, in Form 3 some questions directed toward applying knowledge.

Cooperative Biology Test, by Paul E. Kambly. Cooperative Test Division, Educational Testing Service, Princeton, New Jersey. Copyright, 1948. Two forms: X and Y. For high school students with one year of biology. Machine scorable. Time: 40 minutes.

Deals with fundamental concepts in biology and places emphasis on understanding and application. Norms given for students with one year of biology, in form of percentiles. Number of students to which the test was administered seems to establish the reliability of the norms. A rigorous procedure was set up for preparing and editing the test items, for administering experimental forms to a representative sample of students, and for administering the final form to determine scaled scores and percentile norms.

Cooperative Biology Test, by a Committee on Biology Tests, Educational Records Bureau, 21 Audubon Ave., New York 32, N. Y. Copyright, 1958. Two forms: ERB-RY and ERB-SY, each with three parts. For high school students with one year of biology in independent schools. Machine scorable. Time: 40 minutes.

Purpose of the test is to measure achievement in biology. Designed for independent schools, but difficult enough to be used at the college level. Tests understanding and recall of biological facts. Norms based on test results in independent schools. Questions carefully selected and worded and cover a wide range of information.

General Biology Test, by Lester D. Crow and James G. Murray. Acorn Publishing Co., Rockville Centre, N. Y. Copyright, 1951, 1958. One form: A, with three parts. For Grades 9-12. Not machine scorable. Time: 35 minutes.

Concerned with the applied aspects of biology (Part I), knowledge about biological scientists (Part II), and biological facts (Part III). Scoring can be done without a key since the right answer is preceded by a letter from the word "education." The key might be guessed by students. Percentile norms given, based on a large number of students from different states. Some ambiguity in questions noticed.

Hanes-Benz Biology Test, by G. M. Hanes and H. E. Benz. C. A. Gregory Co., 345 Calhoun St., Cincinnati, Ohio. Copyright, 1939. Two forms: A and B. For end-of-course comprehensive achievement test for biology students. Not machine scorable. Time: 40 minutes.

Chiefly an achievement test which measures little beyond the sheer recognition of biological facts. Norms in the form of percentiles provided, based on a limited number of students in different schools and different states. The first 30 items are true-false, a type of item often regarded as of questionable worth.

Kilander Health Knowledge Test, by H. F. Kilander. World Book Co., Yonkers-on-Hudson, N. Y. Copyright, 1951. Two forms: AM and BM. For Grades 9-12. Machine scorable and hand scorable with a perforated stencil. Time: 40 minutes.

Measures a student's knowledge and understanding of matters pertaining to health and his attitudes and practices in this field. Great care was taken to select the content by analyzing textbooks, materials published by health organizations, courses of study, research studies. Items selected after experimental forms discovered difficulty indices, adequacy of directions, coverage of topics, etc. A Manual of Directions gives complete and detailed directions for administering and scoring and gives standard scores and percentile norms based on a large sample in different schools in different states. Questions carefully worded and without error.

Midwest High School Achievement Examination—Biology, by George H. Ramharter (Form A), and E. C. Halvorsen (Form B). Educational Test Bureau, Educational Publishers, Inc., Minneapolis. Copyright, 1955. Two forms: A and B, each with numerous parts. For high school students with one or two semesters of biology. Not machine scorable. Time: Form A, one hour; Form B, no time limit.

Measures chiefly mastery of specific bits of information although the manual states that it makes a real effort to stimulate thinking ability. Some topics receive more attention than others. Questions carefully worded and no errors noticed, but no information about the procedure of selecting items or constructing the test given. Some questions are true-false and of questionable value. Some norms in the form of percentiles given, but no information about the number of students upon which they are based.

Nelson Biology Test, by Clarence H. Nelson. World Book Co., Yonkers-on-Hudson, N. Y. Copyright, 1951. Two comparable forms: AM and BM, each with two parts. For students at the end of a biology course. Machine scorable and hand scorable with a perforated stencil. Booklets re-usable. Time: 40 minutes.

Designed to test things other than knowledge of facts: understandings, cause-effect relationships, interpretation of data, problem solving, abilities to evaluate experimental procedures and situations with scientific implications. Considerable effort was made to give the test validity including examination of textbooks, journals for science teachers, bulletins, and other science publications. Three experimental forms were developed to obtain difficulty indices and criticism of teachers. Norms based on large numbers of students in many schools in many states. Questions carefully worded and selected; easy to follow.

Williams Biology Test, by John R. Williams. Bureau of Educational Measurements, Kansas State Teachers College, Emporia. Copyright, 1934. Forms: three tests (I, II, III), each with two forms, A and B. For students with one year of biology. Not machine scorable. Time: 40 minutes.

Test I covers structural and animal biology, Test II, human biology, and Test III, plant biology and the relationships between plants and other organisms in the environment. The test is said to have resulted from the examination of textbooks, criticisms and suggestions made by teachers, study of errors of students taking the test, and the relationships between test scores and teacher grades, but no details are given. Percentile norms are said to be based on a large number of student scores in a large number of representative schools, but no details are given. Measures chiefly recall of facts. No questions require application of knowledge to new situations or problem solving. Wording is clear for the most part.

CHEMISTRY TESTS[3]

Achievement Examinations In Chemistry, by Walter W. Cook, Clarence Boeck, Robert Molkenbur. Educational Test Bureau, Educational Publishers, Minneapolis. Copyright, 1951, 1952, 1953. Forms: 1, 2, and 3. For high school students with one year of chemistry. Not machine scorable, and no hand stencils provided. Time: Form 1 about an hour; Forms 2 and 3, 90 minutes.

An achievement test with the first items requiring simple recall, and the other items asking judgments about a single statement or situation. All questions are four-response multiple choice. The validity of

[3] List compiled and tests reviewed by Walter E. Hauswald, Science Instructor, Sycamore High School, Sycamore, Illinois.

many items is questionable since they refer to industrial, household, and technical applications of chemistry with a neglect of theoretical and fundamental aspects of the subject. Many items poorly worded and poorly edited, with spelling errors, ambiguous answers, and even errors in the answer key. Some questions worded so that the answer is obvious. Print difficult to read. Norms given in widely spaced percentiles.

ACS-NSTA COOPERATIVE EXAMINATION IN HIGH SCHOOL CHEMISTRY, by a committee of teachers of chemistry appointed by the Examinations Committee of the Division of Chemical Education of the American Chemical Society and the National Science Teachers Association. Examinations Committee of the American Chemical Society, St. Louis University, 1402 S. Grand Blvd., St. Louis, Mo. Copyright, 1957. Forms: N, now available; a second form available spring, 1959, with other forms planned each two years, each with two parts which can be used separately. For high school students at end of one year of chemistry. Machine scorable and hand scorable with stencil. Time: Form N, 90 minutes, each part 45 minutes; Form 1959, 80 minutes, each part 40 minutes.

First high school test published by a group which has published many college chemistry tests. Resources of the Committee contribute to the excellence of a highly reliable instrument. Items constructed with great care, over a wide range of subject matter, and emphasize fundamental concepts rather than recall of vocabulary and technical and industrial applications of chemistry. Widely used as a high school achievement test and as a placement test for incoming college students.

ANDERSON CHEMISTRY TEST, by Kenneth E. Anderson. World Book Co., Yonkers-on-Hudson, N. Y. Copyright, 1950. Two forms: AM and BM. For high school students with one year of chemistry. Machine scorable, and hand scorable with stencils. Time: 40 minutes plus time for directions.

One of the Evaluation and Adjustment Series for secondary schools designed to evaluate individual pupil achievement and group achievement. Coverage of subject matter is only fair, since important areas are omitted. Test not designed as a diagnostic instrument and does not measure the individual's mastery of aspects of chemistry. Test does, however, help teachers to analyze the achievement of the entire class. By administering the whole series of tests, achievement in chemistry can be compared with other types of learning.

COOPERATIVE CHEMISTRY TEST, by Paul J. Burke and Joseph F. Castka. Cooperative Test Division, Educational Testing Service, Princeton, New Jersey. Copyright, 1947, 1948, 1950. Three forms: X, Y,

and Z. For high school students with one year of chemistry. Machine scorable and hand scorable with stencil. Time: 40 minutes.

Designed to measure achievement for purpose of identifying pupils who merit special attention because of handicaps or special performance and of previewing the status of a class at the beginning of a course. About half of the items in Part I require simple recall of information, and the other half application of principles. Part II includes items which require interpretation of data on charts and graphs, judgments based on application of specific scientific principles. Norms given for various areas in the U. S. Considerable effort was made to insure the validity of the test. Some of the concepts emphasized in the test might be questioned, such as recognizing the correct name of a process or chemical principle rather than understanding the significance of it. Test items are not arranged in order of difficulty. Directions are simple and clearly stated.

KIRKPATRICK CHEMISTRY TEST, by E. D. Kirkpatrick. Bureau of Educational Measurements, Kansas State Teachers College, Emporia. Copyright, 1940. Forms: two tests, each with two equivalent forms, each with five parts. For high school students with one year of chemistry. Not machine scorable. Time: 40 minutes.

A group achievement test covering definitions, formulas, principles, equations, theories, and simple problems. Much of it requires recall of rather inconsequential information. Few questions measure understanding or broad principles and fundamental concepts. Items are true-false, multiple choice, matching, with the right responses somewhat controversial. The newer concepts of chemistry, of course, are not included. General statements of how the test was validated are given, but no details. Percentile norms, at five percentile intervals, are given, based on a limited number of students.

MIDWEST HIGH SCHOOL ACHIEVEMENT EXAMINATION —CHEMISTRY, by Robert Molkenbur (Form A), and H. O. Bergee (Form B). Educational Test Bureau, Educational Publishers, Minneapolis. Copyright, 1955, 1957. Forms: A and B. For students with one year of high school chemistry. Not machine scorable; no stencils provided for hand scoring. Time: Form A, not given, presumably one hour; Form B, 90 minutes.

One of a series of end-of-the-year achievement tests. Items in many cases identical to those in earlier Achievement Examinations by this publisher. Two forms are in no way equivalent or comparable. Form B gives somewhat more adequate coverage to the area, but both forms contain inaccuracies, misspellings, more than one (or no) correct answer. Their reliability and validity is somewhat questionable and they are inconvenient to score.

GENERAL SCIENCE TESTS[4]

AMERICAN SCHOOL ACHIEVEMENT TESTS, Science Information Test, by Willis E. Pratt and Clara E. Cockerville. Public School Publishing Co., Bloomington, Ill. Copyright, 1957. Three forms: D, E, and F. For high school students; grade level not given. Self-scoring, no separate answer sheets required. Time: 25 minutes.

Attempts to measure science information. Content completely verbal with no presentation of pictorial materials. Areas covered: animal life, plant life, physical changes, earth study, sky study, elementary chemistry. Only the first three areas are included in the elementary form; all are included in the intermediate form. The 40 items are arranged in order of increasing difficulty and based on concepts taken from widely used textbooks and courses of study. Intended to measure pupil progress and individual instruction, and to aid in remedial instruction.

COOPERATIVE GENERAL SCIENCE TEST, by Paul E. Kambly. Cooperative Test Division, Educational Testing Service, Princeton, N. J. Copyright, 1948.

[4] List compiled and tests reviewed by Vernon C. Lingren, Professor of Education, and Frank Paulowski, Lecturer in Education, University of Pittsburgh.

Two forms: X and Y. For students in Grades 7, 8, and 9. Machine scorable. Time: 80-85 minutes.

Intended primarily as an achievement test. All items are multiple-choice. Each form divided into three parts: Part I consists of 75 items dealing with informational background; Part II tests knowledge of both terms and concepts; Part III consists of passages, tables, and diagrams that present scientific problems and experimental research. Although the test time is 80 minutes, it may be divided into two different periods. Norms given in percentile rank tables and scaled score tables which show the standard error of measurement.

McDougal General Science Test, by Clyde R. McDougal. Bureau of Educational Measurements, Kansas State Teachers College, Emporia. Copyright, 1942. Two levels: one for end of first semester of a high school general science course and one for the termination of the course. Each level, two forms: A and B. Machine or hand scorable. Time: 40 minutes.

Intended primarily as an achievement test, but authors suggest its use to judge efficiency of instruction, to analyze student and class weaknesses, and to motivate student effort. Each test divided into three parts: Part One requires choice of suggested completions for various given statements; Part Two requires the best answer to posed questions; Part Three requires matching of words with their descriptive phrases. Contains 160-170 items.

National Achievement Tests, General Science Test, by Robert K. Speer and Samuel Smith. Acorn Publishing Co., Rockville Centre, N. Y. Copyright, 1939 and 1950. Two forms: A and B. For Grades 7-9. Not machine scorable. No separate answer sheets. Time: 35 minutes.

Constructed as a diagnostic test, and divided into six parts: Part I deals with general concepts; Part II consists of 20 items on identification; Part III is a matching test of 10 items on the association of noted scientists' names with their achievements; Part IV is a matching test of 15 items in which the student associates a scientific term with its definitions; Part V consists of 20 items in which the name of a machine, device, or instrument is matched with its use; Part VI consists of 35 multiple-choice items concerning miscellaneous facts. The test appears to include a good sampling of general science subject matter.

Read General Science Test, by John G. Read. World Book Company, Yonkers-on-Hudson, New York. Copyright, 1951. Two Forms: AM and BM. For Grades 9-12. Machine or hand scorable. Booklets re-usable. Time: 40 minutes.

Test is constructed to measure achievement of important objectives of high school general science and an attempt is made to sample understanding of principles of science and scientific attitude. Content based on objectives and materials included in textbooks, state curricula, and courses of study, and Thirty-first and Forty-sixth Yearbooks of the National Society for the Study of Education. Standardization data obtained from schools in 22 states. Items distributed among physics (42%), biology (28%), chemistry (4%), and general topics (weather, climate, communication, transportation, geology, astronomy, space, and scientific method) (26%). Manual contains norms for students with one year of general science.

Natural Science

Iowa Tests of Educational Development, Test 2, General Background in the Natural Sciences, by Robert Ebel. Science Research Associates, Inc., 57 W. Grand Ave., Chicago. Copyright, 1951. One form: Y-2. For high school students and college freshmen. Machine and hand scorable. Time: 60 minutes.

The test is designed to measure general knowledge and understanding of scientific terms and principles of common natural phenomena and industrial applications and of the place of science in modern civilization. The test is intended to reveal differences among pupils in a single grade in a single school. Comparisons can be made with (1) the national norms, (2) the average score for your own school, and (3) other information about the student. The manual suggests extra activities for the high-scoring students and means of understanding and helping the low scorer.

PHYSICS TESTS[5]

Achievement Examination for Secondary Schools, Physics, by Kenneth A. Berg. Educational Test Bureau, Educational Publishers, Inc., Minneapolis. Copyright, 1953. Three forms. For high school students upon completion of one year of physics. Not machine scorable. Time: 1½ hours.

No statistical data on reliability are provided. Some items need revision. Seems heavily weighted with items on electricity; otherwise samples all areas in physics with items of varying difficulty.

Cooperative Physics Test, by Paul J. Burke. Educational Testing Service, Princeton, New Jersey. Copyright, 1947-1950. Three forms: X, Y, and Z. For students with from 1-3 semesters of high school physics. Machine or hand scorable. Time: 40 minutes.

Helpful tool for evaluating the student on the basis of achievement in subject matter. Information to be

[5] List compiled and tests reviewed by John G. Read, Professor of Education, Boston University.

obtained from the test includes not only a measure of the student's capabilities and achievement, but a basis for guidance and suggestions of areas in which the course should be improved. Somewhat more than one-third of the test devoted to mechanics and properties of matter; somewhat less than one-third to magnetism and electricity; rest divided between heat, wave motion and sound, and light. Proportion varies somewhat among the three forms. Of the 77 multiple-choice items, only a few involve fundamental definitions; others, the application of principles. Easy to administer; contains adequate directions and provides instructions for converting raw scores into scaled scores and percentile ranks.

Cooperative Physics Test, compiled by the Committee on Physics Tests of the Educational Records Bureau. Educational Testing Service, Princeton, New Jersey. Copyright, 1957. Forms: ERB-RY now available; SY and TY planned for 1959, all with two parts. For students in Grades 11-12, in first year physics. Machine or hand scorable. Time: 80 minutes.

An achievement test, a revision of earlier forms used in annual spring testing programs. Its 87 items are of the multiple-choice type, some with only one correct choice, others with one or more. Items sample all the traditional topics of physics and include a few items on modern atomic physics. Main emphasis is on electricity. First two sections designed to test knowledge and facts, concepts, and relationships, and include some unusual questions about what information one would need to obtain a solution. Directions for the sections tell the student to mark all choices they consider correct. Provision is made for subtracting for wrong answers. Third section is based on a reading passage. Anwers to the items require correlation, discrimination, and analysis to a degree somewhat high for the grade level. Median score is 34 out of 118.

Dunning Physics Test, by Gordon M. Dunning. World Book Comany, Yonkers-on-Hudson, N. Y. Copyright, 1950. Two forms. For high school physics classes, presumably Grades 11-12. Machine or hand scorable. Time: 45 minutes plus 10 minutes for directions.

Designed to measure the "extent to which students have achieved the important objectives of a high school course in physics, not only knowledge of basic facts, principles and laws of physics, but also the ability to understand and apply these." Content well divided among the fields of mechanics, heat, sound, light, electricity, and atomic-related physics. Standardized on large population. Form clear; directions concise. Since questions are taken topic by topic and the item-difficulty values are given, the teacher can rather readily assess the relative mastery of his class of the various topics. The two forms are of equal difficulty and are equal in respect to the distribution of item difficulty, thus making it possible to use one form for a pre-test and the other for a post-test.

Fulmer Schrammel Physics Test, by V. G. Fulmer and H. E. Schrammel. Bureau of Educational Measurements, Kansas State Teachers College, Emporia. Copyright, 1934. Form: one, Form A. Presumably for students in Grades 11-12. Not machine scorable. Contains 100 items. Not timed.

Since no norms are given, the test is most useful for repeated administration in a school system for the purpose of obtaining local norms. Contains many good items and a broad sampling of the whole field. Could serve as a basic model for the development of a local test suited to the needs of a community, but it needs an added section on the understanding of concepts and perhaps some questions involving calculation. Contains 70 true-false items, 10 multiple-choice items, and 20 items with completions chosen from a 31-unit list of answers.

Midwest High School Achievement Examination, Form A, Physics, by V. B. Rasmusen. Educational Test Bureau, Educational Publishers, Inc., Minneapolis. Copyright, 1955. More than one form. No grade level given. Not machine scorable. Time: 1 hour.

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in most cases. Presumably, many hours must be spent by the sponsor in working with his science students on science projects.

In the evaluation study, the percentage of questionnaires returned forced the author to assume that both teachers sponsoring winners and those sponsoring honorable mention students were select representatives of the over-all sponsors' group. There were seemingly no visible differences between the teachers sponsoring winners and those sponsoring honorable mention students.

The following information, then, is applicable to the over-all SAAS sponsor group contacted.

Male teachers comprised 57 per cent of the combined groups with 43 per cent being females. The median total number of entrants per sponsor in the SAAS program is from three to five students while seven per cent of the sponsors reported entering a total of more than 50 students in the six years of the contest. The teachers were interested in other science award programs since 78 per cent stated that their SAAS students have won other science awards. The size of the school seemed important, since 75 per cent of the teachers taught school where the total school population was greater than 500 students. The greatest number of teachers were in the senior high schools with grades nine through twelve, with 72 per cent of this specific group teaching in schools with more than 500 students. Junior high schools with grades seven through nine had 27 per cent, while senior high schools with grades 10 through 12 had 20 per cent of the teachers that responded in this study. An analysis of the teaching assignments revealed that approximately one-third of the teachers taught only one science subject, while another one-third taught only two science subjects. Fifty-eight per cent of the sponsors taught only science while an additional 20 per cent taught science and mathematics. The single subject and dual subject assignments would come with the larger school enrollments.

Science projects were required by one-third of the sponsors, while class credit was given by 70 per cent, and one-third of the sponsors allowed class time for science projects.

The sponsors were highly educated, with reference to degrees earned and number of college

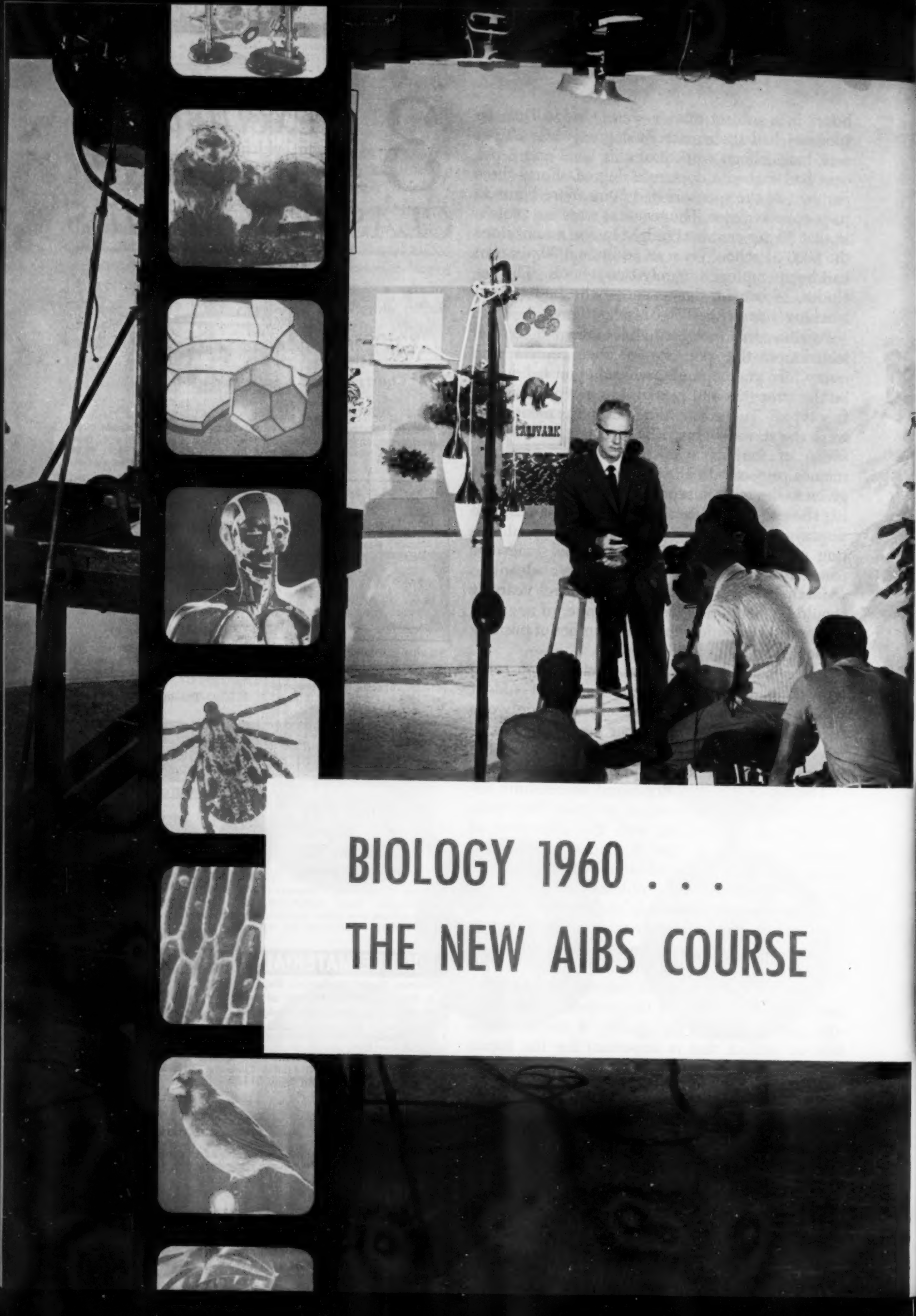
hours in a subject matter area. One-half of the sponsors had their master's degree while 20 per cent had college work past this level and 3 per cent had earned a doctorate degree. Forty-three per cent of the sponsors had 50 or more hours in their college major. The teachers were not mobile in that 50 per cent had taught in one school since the 1950-51 school year; an additional 30 per cent had been employed in only two schools. This includes, of course, the teachers who had started teaching since the 1950-51 school year.

Possibly the most valuable information collected from the sponsors was their reply to the query: "In your opinion, what do you believe to be the strengths and weaknesses of a program of this type." The outstanding strengths mentioned were the stimulation, encouragement, and recognition of various science activities, especially science projects. In addition, strong support was given to the written report as a method of reporting the project, rather than submitting an artistic display. Sponsors thought, however, that submitting only a written report might be somewhat restrictive, and that the program's deadline (March 15) was too early in the school year. It should be mentioned that the number of negative responses was far less than the number of positive responses to this specific query.

It was found that when the teachers sponsoring winners were compared on the number of student winners, 75 per cent of the teachers had only one regional winner, while 25 per cent had two or more regional winners. In fact, 13 per cent of the teachers had sponsored 37 per cent of winners.

The SAAS is a well organized successfully administered science incentive program for youth. The program coincides with the objectives of science teaching in that it places an emphasis upon the ability to do individual work on science projects which are real problems to the students. Science projects allow able students to work to their fullest, and by encouraging project work in science, the SAAS program is a valuable aid to science education in the nation's schools.

Although the number of entrants in SAAS has increased, the quality of the projects entered has also increased. It is the quality of the investigation or project that is important for the future success of the program. The quality, however, seems related to the degree to which the science teacher challenges and works with science students. It is the science teacher, then, upon which the SAAS program depends in order to realize to the fullest extent the total objectives.



BIOLOGY 1960 . . .
THE NEW AIBS COURSE

Reports of the creation of a contemporary secondary school biology course making extensive use of film began to appear in the spring of 1959. Yet groundwork for the project—the first and only such course project fully sponsored by a national professional association, prepared by nearly two hundred teaching biologists, and distributed by a major text publisher—was first laid in 1955. What is it all about? What is the AIBS? What are the purposes of the project? Will it replace today's teachers? Here are three articles relating to that project: the first defines the role of AIBS and some of its activities; the second describes the project itself; in the third a teacher speculates on its effect not only on students but also on teachers.

OSWALD TIPPO
Chairman, AIBS Education Committee
Chairman, Department of Botany, Yale University
New Haven, Connecticut

THE AIBS EDUCATIONAL PROGRAM

The American Institute of Biological Sciences has been described as organized biology at the national level. It is composed of 41 professional societies with an unduplicated representation of more than 75,000 biologists. About 75 per cent of its members are teachers of biological sciences. Many of its members are also members of the National Association of Biology Teachers and the National Science Teachers Association.

In 1955, two years before Sputnik, the AIBS appointed a Committee on Education and Professional Recruitment. During that committee's four years of existence, it has concerned itself with various activities and projects. At the beginning it initiated a visiting lecturers program, with National Science Foundation and Atomic Energy Commission support. In this program outstanding biologists, both investigators and teachers, visit college campuses, especially of smaller colleges, where for a few days at a time they lecture to classes and other groups, present laboratory demonstrations, and confer with faculty and students. Recently the NSF approved an additional grant which will make possible the extension of this program to the secondary schools of the country.

Early in its discussions, the committee also gave consideration to the use of films in teaching, since this is one way to extend the availability of those who have great talent for teaching and, in addition, advantage can be taken of some of the unique contributions which the camera can make to classroom teaching. The AIBS, therefore, is sponsoring the production, with the aid of an NSF grant, of two *experimental* films which are being designed for beginning college level instruction in botany, biology, and zoology, although the committee feels these films will be useful in secondary schools as well. Since they are experimental films, the committee purposely chose to make one film in an area requiring detailed microscopic preparation, the highly visual area of meiosis, which is often poorly taught even though it is most fundamental to the proper understanding of genetics. The other film is in a theoretical area of biology, evolution, and should be a real test of the potentiality of the camera. Supervising this project is Professor H. Burr Roney of the University of Houston, who has had considerable experience and success in the preparation of films, as well as television programs in biology. For each film, the committee has appointed an advisory group of consultants made up of experts in the field, augmented by experienced classroom teachers. In this way it is hoped to insure the achievement of scientific accuracy as well as the utilization of the best pedagogical methods.

Concurrent with the production of these two experimental college level films, the AIBS Education Committee decided to embark on an extensive and thorough-going study of biology education at *all* school and college levels. It, therefore, set up a Curriculum Study Group in the biological sciences which will consider biology instruction at the elementary school, junior high school, senior high school, college, and graduate levels. In making appointments to this long-range study group, the Education Committee has again tried to achieve wide representation from the several areas of the biological sciences as well as from the various educational levels. The committee was fortunate in being able to persuade Dr. Bentley Glass of Johns Hopkins University to assume the chairmanship of this important group. Dr. Arnold Grobman, University of Florida, is director of the study, which is located at Boulder, Colorado.

In the meanwhile, since this long-range study will require considerable time for its work, the AIBS Education Committee was convinced that something should be done *immediately* for secondary school biology, and instituted the creation of a complete secondary school biology course using film lecture-demonstrations coordinated with study guides and teacher manuals. A grant for the preparation of this course was received from the Ford Foundation. Preparation of the course is under the general supervision of a steering committee, and director of the project is Dr. Burr Roney. This project is described in detail in the following article.

In conclusion, let me say that the AIBS and the members of its projects and various committees are all most anxious to have suggestions and criticisms from all members of the biological community; we are sure we cannot succeed unless we have the active participation and assistance of all our colleagues.

AIBS COMMITTEE ON EDUCATION AND PROFESSIONAL RECRUITMENT

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Dean Ronald Bamford, University of Maryland

Dr. John Bodel, The Hotchkiss School

Dr. Harriet B. Creighton, Wellesley College

Dr. David E. Davis, Johns Hopkins University

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Assistant to the Director: Mr. Jack Steuerwald, Houston, Texas

Writers: Mr. William H. Amos, St. Andrews School
Mr. Joseph P. McMenamin, Oak Park and River Forest High School

Demonstrations and Preparations Consultant: Mr. Robert B. Lewis, Aspen Public School

JOSEPH P. McMENAMIN
American Institute of Biological Sciences
Chairman, Department of Biological Sciences,
Oak Park and River Forest High School, Oak Park, Illinois

THE AIBS BIOLOGY COURSE

The AIBS secondary school biology course is, in a very real way, the first stage in the AIBS long-term course content study, which will examine the biology curriculum at all teaching levels in the United States.

Accepting the premise that a knowledge of biology is as indispensable to the educated man as are the other sciences and the humanities, and recognizing the present need that exists for better schools, better teachers, and better courses, the AIBS Education Committee agreed from its inception on the urgent requirement to provide a contemporary biology course *now* for the secondary school level.

While better schools are only indirectly a concern of the AIBS, the committee felt strongly that the AIBS should concern itself immediately with the creation of a sound contemporary biology course—a course to be determined by the nation's leading biologists in all fields, to be sponsored by the one national professional organization representing some 75,000 biologists, and to make the fullest use of the most effective methods of bringing to students everywhere teaching of the highest possible order of excellence.

This is the pattern, in its barest outline, that has been followed in the creation of the AIBS course.

Briefly, the course consists of 120 half-hour basic lecture-demonstration films, available in color, and black and white. These 120 "lectures" are divided into ten major topic areas, of twelve films each. A teacher's manual and study guides are being written in close coordination with the films.

Nine major objectives were agreed upon for the new course:

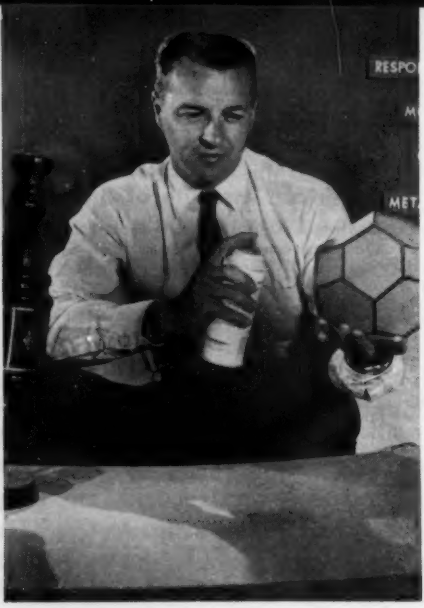
1. That the course would have more emphasis on contemporary biology than is usually taught now at the secondary school level,
2. That the best teaching methods possible would be incorporated,
3. That principles and concepts would take precedence over descriptive details and rote learning,
4. That important fundamentals would be stressed,
5. That all varieties of organisms would be included,
6. That the ten major parts, and even to some extent, the individual films, would permit flexibility for sequence adjustment,
7. That the widest possible participation of the nation's biologists would be sought in the preparation of the course,
8. That the course could be purchased in whole or in any part, and
9. That the fullest use would be made of the camera medium, within the limitations of the funds available.

Eighty-five biologist consultants,[1] each recognized as a specialist in his field, accepted invitations to meet in small groups to create the course. These meetings resulted in specific recommendations for the content of each of the ten major areas of the course: (I) Cell Biology, (II) Microbiology, (III) Multicellular Plants, (IV) Multicellular Animals, (V) Reproduction, Growth and Development, (VI) Genetics, (VII) The Diversity of Plants, (VIII) The Diversity of Animals, (IX) Ecology, and (X) Time, Life, and Change.

To help insure optimum results the consultants and the Steering Committee agreed that seven continuing themes should be "threaded" through the entire course, to be emphasized wherever appropriate. The themes, given here not necessarily in order of importance, are:

1. Organism-matter-energy relationships,
2. The continuity of organisms through time,
3. Organism-environment relationships,
4. Structural and functional relationships,
5. Conservation, and man's role in nature,
6. The ever-growing, open-ended aspects of the scientific process, and
7. Behavior and its adaptive significance.

[1] See *AIBS Bulletin*, April 1959, for complete list.

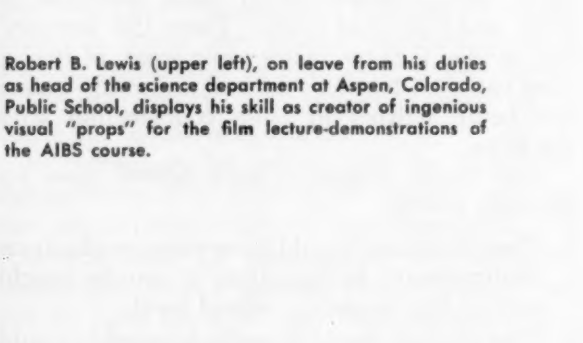


William H. Amos and Joseph P. McMenamin (above) work closely together during the writing of the course study guides and teacher manual. Written materials for the course are being carefully integrated with the films to amplify and reinforce them. Special materials will be included in the teacher manual to aid in certain new areas, as well as suggesting field and laboratory programs. An advisory group aids the writers with recommendations for the structure and organization of the guides and manuals.

Robert B. Lewis (upper left), on leave from his duties as head of the science department at Aspen, Colorado, Public School, displays his skill as creator of ingenious visual "props" for the film lecture-demonstrations of the AIBS course.

Burr Roney, director of the AIBS secondary school biology course and principal teacher in the films, has had perhaps more experience with direct-teaching television and films than any other teacher in the country. Following 17 years of classroom teaching, he has taught an estimated 3000 students in more than 500 hours of televised biology instruction since 1953 on the nation's first educational television station (KUHT, University of Houston). His total non-student audience has sometimes reached 10,000 for one lecture! Dr. Roney has also filmed this college course, as well as two series for national ETV showing.

Some of the AIBS project Steering Committee members relax during their February meeting at Santa Barbara. Standing are Frank Lindsay, L. S. McClung, Richard Paulson (observer, NSF), Oswald Tippo, Joseph P. McMenamin. Seated are Ralph W. Gerard, Lorraine Cicala (AIBS staff), Dorothy Matala, Burr Roney, James G. Dickson (President, AIBS).



Working closely with Dr. Burr Roney in the preparation of this course are two teachers with wide experience in secondary school biology: Mr. William H. Amos, chairman of the Science Department of St. Andrews School, Middletown, Delaware, who is also editor of the University of Delaware's *Estuarine Bulletin;* and Mr. Joseph P. McMenamin, chairman of the Department of Biological Sciences at Oak Park and River Forest High School, Oak Park, Illinois, who has been teaching also at both elementary and college levels.

Recommendations on techniques and methods for the study guides and teachers manuals are being made by an advisory committee. Critical review of the grade level of scripts and written materials is being given by a large group of teachers whose experience has been primarily with high school biology. More than one hundred persons, either teaching, or interested in secondary school biology, were recommended by a group including staff members of the National Science Teachers Association and the National Association of Biology Teachers and were invited to serve as reviewers.

The capital for the production and distribution of the course films, study guides and teacher manuals is being supplied by the McGraw-Hill Book Company, and the films are being made by Calvin Productions, Inc., of Kansas City, Missouri. The AIBS, of course, retains full control of all course content.

A word should perhaps be added concerning Dr. Burr Roney and his qualifications as the director and principal teacher in the course. He has taught beginning biology courses for 22 years at Western Reserve University in Cleveland, and at the University of Houston, Houston, Texas. Long interested in both biology and educational techniques, he has for the past five years taught the freshman biology course at the Houston university on live television, and this year completed the first entire college biology course on film.

Dr. Roney will introduce "guest" biologists in some of the AIBS course films, either in the studio "classroom" or in visits with them at their laboratories or in the field.

Naturally objections will be raised on many points. Some will question the directing of the course to the tenth grade level, some will debate the use of film, doubting its effectiveness or will be concerned with its "replacement" of the classroom teacher, and others will worry about a "standardization" of teaching.

The decision to aim the course primarily at the tenth grade was made after long study. A recent staff paper of the National Research Council Committee of Education Policies states that 90 per cent of the high schools of the United States offers biology at the tenth grade. These schools enroll 97 per cent of all high school students. Of this number, 75 per cent take the high school biology course. The committee felt that this course must be aimed at the level now most commonly studying biology, at least until an extensive revision can be made of the present-day science offerings at earlier levels. Before such a revision is made, however, the committee felt that an ill-considered "stampede" to place the present tenth grade biology course at an earlier grade, as a neat and painless solution to a difficult problem, would be both unfortunate and damaging.

The use of direct-teaching film is no longer new. Within the past five years, such teaching films—in physics, chemistry, and in mathematics—have been used, tested and been found highly effective, locally and nationally. Modern instructional film has proved itself a powerful means of bringing teachers and their carefully prepared subject matter to students everywhere, presenting an unparalleled opportunity for increasing the effectiveness of teaching, broadening the minds and backgrounds of learners, and in the end, advancing the teaching profession. If any "catch" is involved in the use of films, it is the same one that applies to the use of textbooks, visual aids, or any other teaching device; the effectiveness of *any* teaching tool rests ultimately with the use the classroom teacher makes of it.

Because the teacher, and his own method of teaching, is recognized as the irreplaceable core of effective instruction, the Education Committee agreed in their first discussions of this course that it must provide the greatest flexibility of use for the most teachers, and that, unlike some of the earlier "film courses," the AIBS course parts would be rearrangeable in a number of ways, and that it would not be presented as an all-or-nothing package. While a "preferred" sequence of study will be recommended, and other possible arrangements will be listed, a teacher may use a single film, or a single topic group, or assemble his own pattern of study from the total of 120 films being prepared.

Such provisions for individual use surely negate fears of any attempted "standardization"

[2] See *AIBS Bulletin*, June 1959, for complete list.

of biology teaching. The committee fully recognized that the caliber of teaching is high in many schools, and that the biology courses at such schools are first rate by any standards. On the other hand, thousands of high school teachers have expressed the desire for aid in preparing and teaching a *better* biology course to their students. And no one can deny the great variation that exists under the label of Biology in our high schools—courses in human hygiene, animal science courses with little or no plant science, and courses that have not kept pace with the rapidly expanding advances in contemporary research.

A sensible and objective evaluation of the AIBS secondary school biology project was given by Dr. Roney when he spoke on this course before members of the National Science Teachers Association at their April 1959 Convention in Atlantic City[3] . . . . "I think of (these films) as . . . a medium of communication from organism to organism, not as ends in themselves, nor as a substitute for any other aspect of communication. The kind of education we are all aiming at needs to make use of field and laboratory experience with the objects and processes studied in biology, and to make use of films, books, magazines, and all forms of printed material, *and to integrate all this, we still need good teachers.* We hope our efforts will be received as they are intended."

[3] H. Burr Roney, "A New Approach to the High School Biology Course." The *AIBS Bulletin*, 9:18-20. 1959.

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TEACHER-IMPROVEMENT VALUES

While the series of films that will compose the lecture-demonstrations of the AIBS secondary school biology course were originally planned primarily to provide maximum aid to all teachers, with widely varying backgrounds, it now appears to me that these films will have much to offer in other situations. As a member of the Steering Committee who is not in direct contact with centers of biological research, and who is primarily concerned with teacher education, I have been made aware during our meetings and in reading the reports of other course content consultants' meetings that some of my ideas, and some of the things that I have been teaching are now out-of-date.

To look at an outline of this course as presented in the previous article is somewhat deceptive. This outline, on the basis of the units chosen, seems fairly traditional in pattern—it would fit most of the current biology texts. The particular sequence suggested may not be every teacher's accustomed one, but, as any sequence varies with texts, this sequence may be varied within the film series.

It is when the contents of each unit are examined that a somewhat different story appears. The content of each unit has been established by a group of specialists in that particular field. Various viewpoints were represented in almost all the groups. Discussions were sometimes warm. But out of these came consensus—usually almost unanimous—as to what should be included in a modern treatment of the material of the unit.

In some cases traditional content and terms have been modified or even discarded. The reasons for such changes are varied; they range from decisions that a term is merely unnecessary to strong feelings that some terms are actually misleading or inaccurate. For example, the consultants on Part V, Reproduction, Growth and Development, would like in the interest of greater clarity to avoid the term *daughter* cell; would prefer to use *parent* cell rather than *mother* cell; and prefer pollen *development* to pollen *germination*. The consultants for Part III, Multicellular Plants, indicated that the following terms could well be omitted: *osmosis; iso-, hyper-* and *hypo-tonic; transpiration pull;* and *semi-permeable*. They recom-

mend, in place of these, the use of such terms as *diffusion; diffusion gradient; diffusion pressure; differentially permeable;* and *transpiration stream.* At the secondary school level, the term *central* or *vascular* cylinder could well be used in place of *endodermis, pericycle,* etc. Perhaps the greatest shock of all to most biology teachers comes when the consultants on Part I, Cell Biology, suggest that *protoplasm* is a misleading and undesirable word and that, similarly, *chromatin* might better be replaced by *chromosome(s)* or, as appropriate, such terms as *nucleoprotein,* DNA, etc. Other terms that were criticized include *resting* cell, spindle *fibers,* and *daughter* chromosomes.

Moreover, throughout the course there runs an emphasis in approach which is not always traditional, and which may not be familiar to some teachers, although the level of treatment which will be used by Dr. Roney and the writers should not make the approach difficult to understand. For example, both the Steering Committee and the consultants have all agreed that such themes as homeostasis, the duality of structure and function, the "organization" aspects of living, and energy flow in living systems are all important themes which integrate much of modern biology. While these concepts are not entirely new to secondary school biology teaching, the consistent emphasis upon them throughout the entire course may be a surprise to some. But it was generally agreed that such themes can and do give unity to all the various aspects of biology.

Because such re-examinations have been frequent in the planning of the course, the films seem to me to have far greater values for use than are sometimes understood. Among these would be (1) in-service training of teachers with little recent biology, as well as those with a minimum training in biology, (2) review of certain rapidly developing areas desirable for the background of even the best teachers, (3) a pattern or outline against which the offerings in a teacher-training program might be checked, (4) up-dating of college staff members who find it difficult to keep abreast in all phases of biology, (5) use of parts of the series even by the best, most up-to-date teachers, because film can present some facets of biology more effectively than any teacher—through the use of animation, views of distant places, special laboratory equipment or experiments, and the participation of outstanding biologists who can be brought "into" the classroom, and (6) use of the course manuals by able teachers for ideas which may add some variety to their usual procedures, or for adding enrichment activities.

Of these uses beyond the regular classroom, the in-service possibilities seem extremely interesting and promising. In a school system, or a group of systems, a program could be established which used the films as the basis of an in-service course. This might be done with a series of weekly meetings, each consisting of a showing of two or three of the films, discussion among the teachers and available consultants, reading of the material in the manuals, and collateral readings. Thoroughly done, such a study sequence should carry some credit either arranged by an associated college, or "barrier" credit should be given by the school system. From such an experience, the teachers should emerge with strengthened understandings, newer viewpoints, more confidence in their own knowledge, and a renewed enthusiasm for their teaching. These, in turn, would have an invaluable impact on their students.

A similar experience might be arranged for groups of college instructors whose students intend to become biology teachers. Such an experience could result in a critical self-examination of the courses they present, their methods and their viewpoints. This, in turn, could have a significant impact on the teaching of biology because secondary school teachers seldom exceed their college teachers in accuracy and "up-to-dateness."

If widely used in such programs related to in-service or pre-service teacher education, these films could result in a kind of yardstick for measuring the content of the high school biology course. It is not the desire of the AIBS Education Committee, nor of any of the people involved with the planning and production of the films, to establish a rigid "standard" biology course for the country. Neither do they see this as *the* definitive course. The fact that many parts of the course will be flexible in their arrangement, and that individual films will be available, reflects this desire to avoid standardization. Teachers are individuals. To be effective each must teach in his own way and by his own method. However, certain basic matters of content and emphasis are common to all good biology courses.

I, for one, am increasingly enthusiastic over the possibilities these films and this course offer for aiding biology teachers of many abilities and at all levels.

TETRAHEDRAL MODELS

By W. E. COWGILL

Chemistry Department, The Pennsylvania State University, University Park

MODELS larger than the standard-sized ball-and-stick molecular models are especially useful in lecture demonstrations. In order to illustrate the tetrahedrally-oriented single-bonding of the carbon atom, the non-linear and non-planar nature of paraffin chains, rotation about bonds, and possible proximity of certain parts of a chain to other parts of the same chain, the "bonds" must be fairly accurate in their placement.

A jig for making tetrahedrally-oriented borings in two-inch cork spheres[1] is herein described.

A 2″x 2″ square-sectioned timber is sawed carefully at the tetrahedral angle, 109° 28′ (Figure 1). It is not feasible to saw to the accuracy implied by the 28′, but good results can be obtained by a 109° cut with a slight bias on the high side. A miter saw is good for this. The calibrations on this tool make it unnecessary to mark off the timber with protractor and pencil.

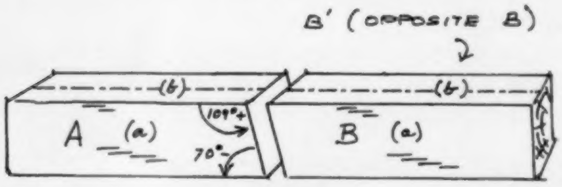

FIGURE 1

2″ timber cut at tetrahedral angle and center-scored along axis on the surface which is 109° and 70° to the face of the cut.

The timbers are trimmed off at any convenient length beyond 5″ from the angled cuts. They are then temporarily fitted together to make a 70° 32′ angle (Figure 2) and marked so that measurements from the inner apex can be taken along the inner sides of the timbers. At a certain distance (1.4″ for 2″-diameter spheres) from the inner apex, and at the lateral midpoints on both timbers, center punch marks are made. This distance from the apex to the markings can be calculated for a sphere of any given radius from:

$$d = \frac{R}{.71}$$

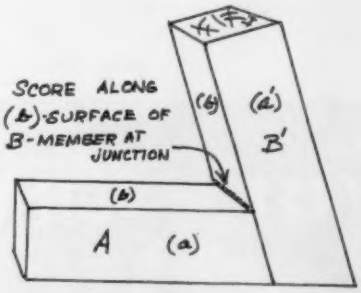

FIGURE 2

Temporary fitting and scoring preparatory to drilling jig holes.

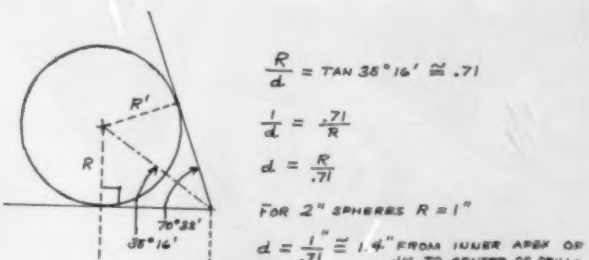

FIGURE 3

Derivation and rationale of distance determination from apex to drill-guidehole as a function of sphere radius.

where R represents the radius of the sphere and .71 is obtained as the tangent of half the apex angle. The rationale of this is given in Figure 3.

The points located above are drilled through

[1] Erno Products Co., 65 North Second St., Philadelphia, Pa., is a source.

with a ¼" bit on a drill press to assure that the holes will be at right angles to the surfaces of the timbers. These holes are countersunk on the outside surfaces by a ½" bit about 1" deep to allow entry of the chuck of the drill when boring spheres. While the 2" thickness of the timber facilitates accuracy in making the angle it does not permit a small drill to penetrate much beyond its inner surface in the use of the jig, unless the countersink is made.

The timbers are then joined, using glue, nails, or both, and care being taken that the timbers do not slip from their previously marked joining positions during fastening.

A triangular backstop reaching at least 1" from the inner apex along its bisector is cut from plywood and fastened on one side. A conspicuous mark is placed along the outside of the backstop such that it indicates a line along the bisector of the angle (Figure 4A and 5).

A 1"x 4" wood piece, a "gate," is bored ¼" from one end and fastened flatly with a wood screw to the side of the apex so that the gate can be swung along the side opposite the backstop. (Figure 4A-1)

A strap-iron L is fastened at least 3½" from the inner apex along the inner center of one of the timbers such that the upright surface of the L is at right angles to the axis of the member upon which it is mounted and also lateral to the member. The L strap should have a hole ⅛" to ¼" in diameter about 1" from its base surface. Into this hole a stove bolt or machine bolt of appropriate diameter and at least 2" long is placed, with a nut on one side of the strap iron and another on the opposite side, and with the head of the bolt away from the inner apex (Figure 4B).

A wooden block about 1"x 1"x 2" (Figure 4B-1) is partially bored with a bit slightly larger in diameter than the bolt. The distance of the center of this hole from the end of the block should be the same as the distance of the axial center of the bolt from its base member (the wooden member). The L strap, the bolt, and the sliding block, together with the gates and the backstop, form a clamp to hold a cork sphere.

Four ¼"-diameter holes are bored in one end of one of the angle members to form storage sockets for the two aligning bonds, one securing bond, and a wooden center punch.

If the main members are no less than 2″ across (lumber measurements may be expected to vary plus or minus 1/16″ or so from stated sizes) it is well to place a cardboard "cushion" on the inner surface of the backstop and to prepare a "cushion gate" to close into place before the wooden gate is closed over it (Figure 4B-2).

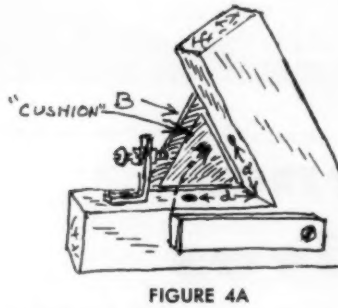

FIGURE 4A

Jig with backstop, gate, and 'L' bolt in position; one "cushion" on backstop 'B.'

In use, a sphere is clamped into place and the whole jig clamped in a vise with one exterior surface level. A ¼″-diameter rod or dowel is sharpened in a pencil sharpener and used as a center punch; placing it down the center of the guidehole, a slight depression is made on the surface of the sphere. Removing the center punch and guiding a 3/16″ bit down the center

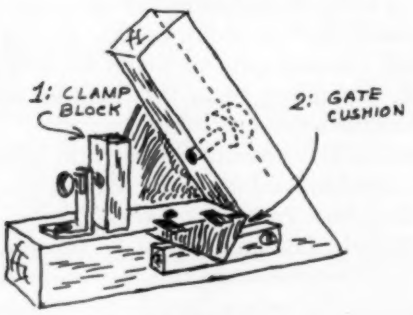

FIGURE 4B

Jig with gate "cushion" (2) and clamping block (1) added to Figure 4A. Countersinking to accommodate drill chuck is indicated on one member by dotted lines. Clamp block, free to slide laterally, is not secured except by pressure of stove bolt.

of the hole, and starting lightly, one boring is made about 1″ deep. The jig is moved in the vise to expose the other side and the process repeated. The jig is removed, sphere removed from jig, and two temporary (aligning) bonds (sticks ¼″ in diameter and about 3″ to 5″ long) are inserted. The sphere is reclamped in the jig while aligning the two bonds with the center-line on the outside of the backstop (Figure 5). This assembly is vised as before.

One of the new holes is drilled in the same manner described above; but this time a third temporary bond is inserted into both the jig and the fresh hole before moving the jig. This insures against serious slippage of the sphere while drilling the fourth hole.

After the fourth hole is bored and the sphere removed the sphere should be correctly bored to form a "carbon atom" of a ball-and-stick molecular model system.

It is well to try to use the guideholes more visually than mechanically thus avoiding wear and facilitating a more constant degree of accuracy.

A "carbon" sphere with but two holes bored in it should be usable as an "oxygen atom." The four-degree discrepancy would not be seriously multiplied in a structure unless the oxygen participated in chain formation as in silicone structures.

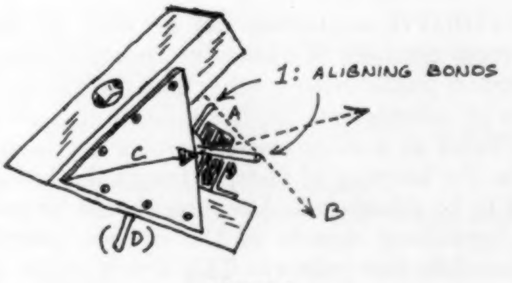

FIGURE 5

Aligning temporary bonds preparatory to clamping sphere in place for drilling third and fourth holes. Dotted line AB should be along the planar bisector of the jig angle and both bonds aligned with sighting line 'C.' The anti-slip bond, inserted after the third hole has been drilled, is indicated by 'D.'

Color-coding by painting (i.e., carbons black, oxygens red, hydrogens yellow) is necessary. A wooden block with about two dozen ¼″-diameter holes drilled into one surface, and as many 6″ dowels ¼″ in diameter, form a convenient painting and drying rack. The dowels inserted in the spheres can be used as handles in painting the spheres, then dowel and sphere socketed in the block to dry.

In the same way, ¼″-diameter dowels 6″ and 4.2″ long[2] could serve as bonds in the model.

Double bonds can be simulated by placing short stubs of dowel in appropriate lengths of pressure-tubing or screen-door spring.

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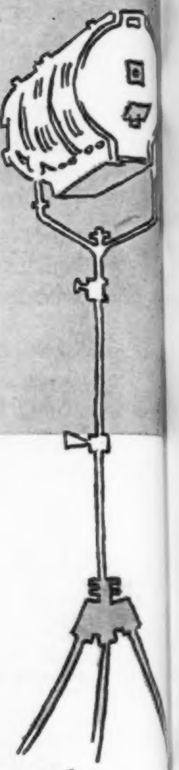
[2] Atomic radii in C-C and in H-H bonds, hence corresponding ratios of bond lengths, can be found in R. Q. Brewster's *Organic Chemistry*. Prentice-Hall, Inc. 1948. p. 7.

SPOTLIGHT on RESEARCH



Evaluation of Science Curriculum Objectives

By WILLIAM B. REINER

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INFORMAL evaluation can be used by classroom teachers of science to appraise achievements of pupils in areas other than the memorization of information. Studies indicate that pupils' activities in science classes involve much more than the learning of facts, although the latter is not to be minimized. Attention should be given to appraising aspects of the science program other than fact mastery. This article points out specific activities that can be observed and informal evaluation tools that can be employed. How problem solving and critical thinking can be appraised by informal means is also discussed.

Informal methods may be used effectively in determining the educational progress and growth of children. Formal methods, such as standardized tests, or school-wide tests require rigid procedures for administering and scoring. Informal methods rely upon the flexible control of the teachers' observations and judgments. Anecdotal records, checklists, self-rating scales, pupil diaries, observation techniques, questionnaires, interviews, and sociograms are examples of informal devices that have been used widely.

Observational techniques are perhaps more effective than formal tests as a means for judging the process of pupil growth in regard to attitudes, interests, creativity, resourcefulness, and adaptability. It is possible to be definite and specific in reporting the observations made in these aspects of pupil development. As a matter of fact, skillful use of concise descriptions and phrases can be of more meaning to the pupil, parent, and teacher for purposes of guidance and grading than a numerical or alphabetical symbol. Codes and tabulation sheets can save time.[1]

Evaluation becomes more effective in proportion to the varied means employed to gather evidence of pupil behavior. Data may be collected regarding the written or spoken work of pupils, or their performance, or products, or observations of their working habits. Rating scales, checklists, photographs, or sound recordings may be used, depending upon the facilities available or the teacher's resourcefulness.

Formal tests frequently suffer from inflexibility in that standardized tests do not always fit the curriculum backgrounds or ability levels of the pupils tested. Informal methods are more flexible in that teachers are familiar with the curriculum experiences and learning abilities of their pupils. Teachers can use them as often as they deem advisable. Informal tchniques are not too difficult for the average teacher to devise and apply. They are conducive to a more relaxing classroom climate. However, informal methods require careful planning and interpretation of results. They do not lend themselves readily to comparing the achievements of various pupil populations.

[1] Joe Young West. *A Technique for Appraising Certain Observable Behavior in Science in Elementary Schools.* Dissertation for the degree of Doctor of Philosophy, Contributions to Education, No. 728, Bureau of Publications, Teachers College, Columbia University, New York. 1937.

Brief anecdotal records or descriptive phrases will have more meaning for rating some types of activities than numerical or letter scores. The teacher will have to be the best judge of this. By combining the ratings or appraisals given in several areas, the teacher will be better prepared to judge the status or achievement of the pupils for purposes of guidance, instruction, or giving grades or marks. A summary of the activities and behavior of pupils which can be used as the basis for guiding or rating pupils is given below.

NSTA Committee on Research

It is planned that this feature series of articles will be continued in TST during 1959-60 as a project of the above committee. The articles will be prepared under the direction of the committee chairman, Dr. William B. Reiner. Author credit will be given for each report in the series.

The full roster of committee membership will appear in a later issue.

Oral Activities or Spoken Evidence

Class discussions or oral reports.
Recitation or oral quiz work.
Reports on radio or TV programs.
Reports on books, magazines, newspapers.
Reports of field trips, visits to museums, zoos, botanic gardens, fisheries, planetaria.
Panel discussions, debates.
Reports of interviews with resource people, scientists, inventors, etc.

Listening Activities

Radio programs on science topics.
Television programs on science.
Week-end lectures at colleges, institutes, or societies.
Attendance at lectures of student organizations interested in science.
Attendance at museum talks, botanic gardens, bird walks, etc.
School club presentations and lectures.

Written Activities

Homework assignments.
Scrapbooks and notebooks.
Reports on laboratory work or demonstrations.
Tests and examinations.
Book reports.
Pupil logs or diaries.
Book reports, pamphlet summaries, magazine reports.
Reports of trips, visits, outings, etc.
Reports on scientific hobbies, personal projects, etc.
Term papers.

Reading Activities

Ordinary class assignments from class text(s).
Supplementary textbook reading.
Magazines and journals of a popular nature.
Scientific and technical volumes or journals.
Newspaper reports of scientific progress.
Biography, history, fiction in science areas.

Creative Activities

Participation in school or district science fairs.
Participation in research projects involving experimental-control situations.
Producing original models, demonstration materials, or laboratory activities.
Contributing novel approaches in scientific hobbies such as photography, crystal growing, mounting of insects or flowers, etc.
Writing of poems, stories, reports on science topics.
Production and participation in science auditorium programs, plays, skits.

Manipulative Activities

Laboratory skills and techniques.
Skill in assisting teacher in preparing and showing demonstrations.
Making models, charts, apparatus.
Care of plants, animals, pets in classroom, or school projects.
Repairing and maintaining equipment.
Collecting and arranging displays of minerals, seeds, chemicals.
Assisting in the setting up of wall or table dioramas.
Skill in wood, metal, or electrical shop activities which contribute to science demonstrations or displays.

Behaviors and Traits

Leadership in class and club activities.
Good work habits in class and out.
Wholesome attitudes, open-mindedness, willingness to work for answers to problems.
Getting along and working well with others in group activities, cooperation.
Worthwhile interests—expressed and participating.
Curiosity and objectivity regarding science matters.

The activities and behaviors mentioned above can be observed and recorded with reasonable accuracy by means of scales or checklists. An illustration of a practical five-point scale type of checklist that can be employed in rating written activities is shown on the next page.

A more ambitious type of informal evaluation may be undertaken in the appraisal of understandings. At the very outset, it should be noted that evaluation of scientific reasoning outcomes by means of formal written tests places a heavy

RATINGS

Activities	*Excellent*	*Very Good*	*Good*	*Fair*	*Poor*
Demonstrations					
Book Reports					
Field Trips					
TV Programs					

reading burden upon the students tested. In addition, the teacher is confronted with the formidable task of constructing test questions which prove pupils' abilities in these complex skills. Teachers can cut down the reading burden by presenting the class as a whole, with an oral problem exercise. The blackboard may be used for listing details of the problem, data, etc. Class discussion and group thinking can contribute to growth in this area.

A teacher's guide to the behaviors met in problem solving is presented in Obourn's summary in *Science Education.*[2] Illustrations and examples of test items involving critical thinking are discussed in *Science in General Education,*[3] and in the work of Smith and Tyler.[4] Excellent illustrations of test items of critical thinking can be found in the work of Heil[5] and his associates, Kambly, Mainardi, and Weisman.

Examples of objectives appraised in this study under the category of *factual understandings* are illustrations of factual generalizations and the use of these generalizations to:

(a) predict an action.
(b) explain a phenomenon, judge the validity of a course of action.
(c) formulate hypotheses.
(d) judge the validity of sources of information, if possible.

Under *method understandings* objectives, illustrations of items are given of:

(a) the proper interpretation of data (recognition of adequacy of samples, interpolation and extrapolation, reasoning by analogy, distinguishing between data and value judgments).

[2] Ellsworth S. Obourn. "An Analysis and Check List on the Problem Solving Technique." *Science Education,* 40:388-392.

[3] "Science in General Education." Report of the Commission on the Secondary-School Curriculum of the Progressive Education Association. D. Appleton-Century Co., Inc., New York. 1938.

[4] Eugene R. Smith, Ralph W. Tyler, and others. *Appraising and Recording Student Progress.* Adventure in American Education Series, Vol. III. Harper and Bros., New York. 1942.

[5] *The Measurement of Understanding,* Chapter VI. Forty-fifth Yearbook of the National Society for the Study of Education, Part I, pages 104-137. 1946.

(b) identifying necessary and unstated assumptions involved in a conclusion, prediction, course of action, or practice.
(c) recognizing and using defensible reasons when justifying a conclusion, prediction, course of action, or practice.
(d) identifying valid cause-and-effect relationships.

Experiences[6] from which test items can be constructed are suggested in the following areas: (a) health, (b) safety, (c) recreation, (d) interpersonal relationships, (e) socio-economic activities, (f) consumer problems, (g) the world of work, (h) conservation, and (i) philosophies of life, as a beginning.

Aspects of critical thinking, such as judging which facts or principles support a conclusion, were measured by Dunning,[7] who identified the steps a science teacher could follow in constructing informal tests. He suggested how the scores obtained from these instruments should be interpreted.

An excellent source of suggestions for items is the STEP series, more fully known as the Sequential Tests of Educational Progress, published by the Cooperative Division of Educational Testing Service, Princeton, New Jersey. The tests attempt to measure the pupils' ability to apply basic concepts of science to problem solving in both familiar and unfamiliar situations. Each test consists of sets of multiple-choice objective questions, each set being based on a single problem situation. For example, one set for grades 4 to 6, deals with the problem of selecting the best of three types of soil—clay, sand, or loam—in which to grow lima beans. Another problem for grade 7 to 9 is concerned with the effects of fertilizer on different plants.

The publishers state that insofar as possible, each test question measures simultaneously a specific skill and a specific concept or understanding. The skills tested are the abilities to: (a) identify, define, or isolate a scientific problem from a mass of given material, (b) suggest hypotheses, suspend judgment, recognize cause and effect, recognize the consistency of a hypothesis; check a hypothesis against laws, facts, operations, or experiments, (c) select validating procedures, design experiments, collect appropriate data, (d) interpret data, draw conclusions from data, (e) evaluate advertisements critically, unwarranted generalizations, superstitions, (f) distinguish between fact, hypothesis, and opinion, and the relevant from the irrelevant, (g) reason quantitatively and symbolically; understanding and using numerical operations, symbolic relations, and information presented in graphs, charts, maps, and tables, or other forms.

Research findings suggest that inquisitive teachers can construct appraisal devices which yield approximate, but nevertheless valuable, information regarding the degree to which pupils can reason critically in science-centered problem areas. Two difficulties encountered are (1) the heavy reading load encountered by pupils in the statement of the problem and (2) the burden on the teacher to select problem situations that challenge the pupils, and yet are not beyond their capabilities. It is suggested that teachers can reduce the reading load by presenting most of the problem orally and listing the needed data on the blackboard. Sources of problems are available in the studies cited in this article and elsewhere. Norms, grade equivalents, and statistics are of secondary importance to the classroom teacher who is interested in exploring the possibilities of informal evaluation as a tool to probe pupils' thinking.

[6] ibid, p. 107.
[7] Gordon M. Dunning. "Evaluation of Critical Thinking." *Science Education*, 38:191-211.

Classroom Ideas

Biology

Study of Circulation

By MYRA LORBERBLATT, James Madison High School,
Brooklyn, New York

This report was an entry in the 1957-58 STAR (Science Teacher Achievement Recognition) awards program conducted by NSTA and sponsored by the National Cancer Institute, U. S. Public Health Service.

THE following laboratory exercise may be introduced following a film on Circulatory Control. A film by this name is issued by the Department of Biology and Public Health of the Massachusetts Institute of Technology.

Each pupil is supplied with veins and arteries obtained from the local butcher. Large quantities may be obtained and should be washed thoroughly.

First the pupil determines by careful observation (texture, musculature, wall thickness) which are arteries and which are veins. (See Figures 1, 2, and 3.)

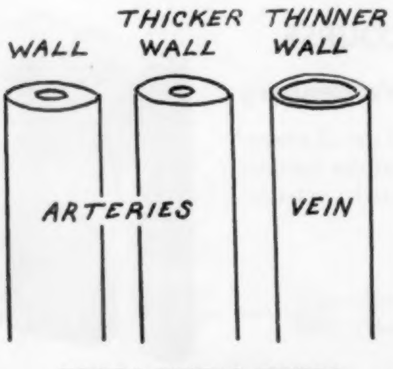


FIGURE 1, FIGURE 2, FIGURE 3
Arteries and vein. Measure same outer diameter but different inner diameters.

Then it is noted that some of the arteries are much thicker than others and because of layers of fat or other tissues within the walls, have narrower openings (see Figures 1 and 2). By placing them under a tap, and turning the water at a steady force, they are observed for varying pressures of the flow. The more rigid ones (thicker walls and smaller openings), show a more forceful flow of water (see Figure 6).

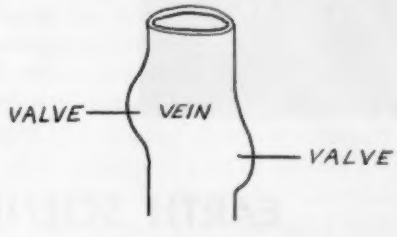


FIGURE 4
Vein under tap showing valves filled with water.

This can be more accurately measured by connecting with a simple manometer (Figure 6) (homemade), and noting variations. Thin, simple sections may be made to show the muscle cells and fat cells, under the microscope. The connection with fat accumulation and atherosclerosis can be brought out. The veins (thinner walled)

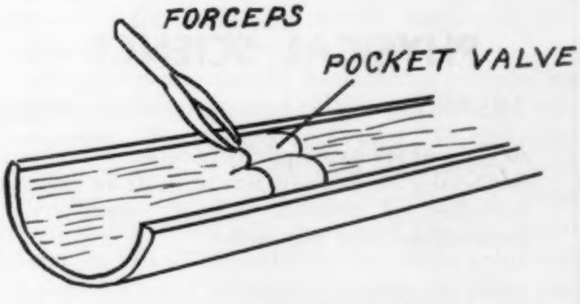


FIGURE 5
Dissected vein.

(Figure 3), can be placed under the tap and the filling of the valves is dramatically demonstrated (Figure 4). (Previously, the pupils have simply hung their arms down and watched the valves in their own veins fill up.) This leads to understanding and discussion of how the valves

maintain the flow toward the heart. A simple dissection of the veins shows the pairs of valves very easily. They are easily picked up with a forceps. The pocket-like nature of these valves is clearly demonstrated (Figure 5).

This exercise takes about thirty minutes and is an introduction to various other studies for which the pupils can easily get material, such as the calf heart, which is a more standard type of laboratory exercise.

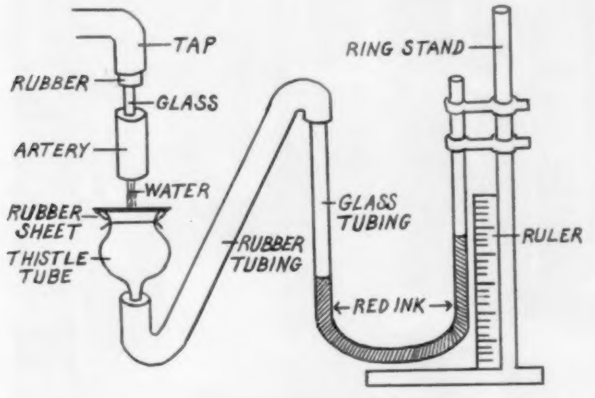


FIGURE 6
Simple, homemade manometer.

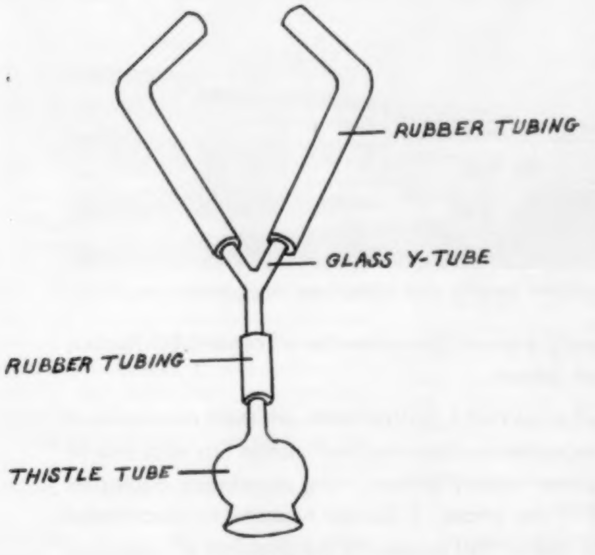


FIGURE 7
Simple, homemade stethoscope.

A simple hand-made stethoscope is passed around the class and each pupil listens to his own heart beat (Figure 7). A record on heart sounds distributed by one of the pharmaceutical companies is run off to give the pupils an idea of how these sounds are recorded. The above technique takes about fifteen minutes.

Physical Science

Color Experimentation

By DARRELL H. BEACH, L'Anse Creuse High School, Mount Clemens, Michigan

When teaching the theory of color, here is a substitute for prism or spectroscope.

The materials needed will cost you less than half a dollar. A box of cake coloring and nine test tubes are the necessary materials, or any common receptacle can be used in place of the test tubes. Most cake coloring kits contain four primary colors: red, yellow, green, and blue. However, the spectrum has a color range of red, orange, yellow, green, blue, indigo, and violet. Following is the method to employ in producing the substitute spectroscope:

Place a few drops of the red sample into a receptacle of the desired size and dilute with water until the desired shade is reached.

Next place a drop or two of yellow and a drop of red into a second receptacle. Continue blending these two primary colors until you get the proper shade of orange.

Using the same method as with the red color, dilute some primary yellow until the desired shade is reached. Use the same method for green and blue as was employed in the red and yellow.

The next two colors (indigo and violet) need some very special care in their preparation. To produce the indigo color blend some primary blue and green until the shade of blue-green matches that end of the continuous spectrum. The violet color may be attained in the same manner as the indigo, by merely employing the same procedure with red and blue.

Altogether you should have seven receptacles with these seven spectral colors: red, orange, yellow, green, blue, indigo, and violet. To make the set complete, fill a vessel with clear water, or if you prefer, make a colloidal suspension of white water paint. This is to represent the combined spectrum. In all probability, the white color will stimulate a lot of discussion, especially when you say that white is not a color but instead all of the spectrum striking the retina of the eye. Now you will want to add a ninth member to your set.

You have guessed it. The ninth member is black. Black is the most difficult member of the set to produce. Take primary green and primary red and blend them in water. You will combine the proportions of each until eventually you will have complete absorption and black as a result.

CONVENTION NOTES

More program innovations and larger attendance are indicated for the Kansas City, Missouri, Convention March 29-April 2 than for any of NSTA's seven previous national gatherings.

This is the word relayed to your editors by our special French Underground, which has wormed its way into secret sessions of the Planning Committee (watch for roster names and picture in October) and has set up listening posts in every corner of the land—even in Chicago and San Jose (where the 1961 and 1962 conclaves will convene). We promise to use this source to the fullest in bringing "Convention Notes" to readers of *TST* during the next few months.

KC CONVENTION THEME

President Decker, it is reported, encountered almost no committee opposition to his proposal of the continuous program in science as the focus of attention in KC. He was strongly supported in this by Mildred "Mims" Ballou (Des Moines, Iowa). College scientists John Bruekelman (Emporia, Kansas), Bob Sherman (Denton, Texas), and Don Henderson (Grand Forks, North Dakota) insisted on attention to scientific research and its applications in various fields. Discussion, then a coffee (?) break, and agreement was reached quickly. Chairman Dorothy Tryon (Detroit, Michigan) ruled that the theme for KC-1960 is: "Current Science and the K-12 Program."

Coordinator of local arrangements Dewey Miner (Kansas City, Missouri) and Sr. Anna Joseph (also of Kansas City) are arranging tours and teacher and student exhibits tied in with this theme. The exhibits, for example, will not be simply a cafeteria offering, but will be arranged to portray teaching and learning about, say, energy through all grades.

Commercial exhibitors, too, will be encouraged to display their teaching materials in a K-12 pattern. (NSTA Headquarters reports that 85 booths, all 10' x 10', will be set up; also that time to visit these will be provided in the program schedule.)

Committeeman Otis Allen (Greenwood, Mississippi) will see to it, we're told, that the ever-popular "Here's How I Do It" sessions also carry out the K-12 theme. (Also, he says to tell all of you who would like a 15-minute spot in these sessions to write to headquarters.)

RELAXATION FROM WORK

"KC is to be the friendliest convention of all," says Edith Link (Holts Summit, Missouri and President of the MSTA). So, our Underground tells us, she and Lucille Berlin (Tulsa, Oklahoma) are arranging *two* mixers at KC—an "early bird" affair on Tuesday, March 29 and a "big western" on Wednesday, the 30th.

The annual banquet will be held Friday evening, April 1, and on Saturday is a special luncheon with the Missouri Science Teachers Association as host (but you buy your own meal ticket!).

Special agent WP tells us that other meal functions scheduled for KC-1960 include a luncheon for supervisors, an elementary science luncheon (new this year), the annual B-I-E luncheon, the Life Members' breakfast, and other breakfasts for college or university and state groups. (Write to NSTA Headquarters to make arrangements for these, also.)

FEATURES

Several top speakers have already been secured for the KC Convention, secured just as firmly as possible at this early date. Among these are: Dr. Linus J. Pauling, Professor of Chemistry at Caltech; Dr. John Fischer, Dean of Teachers College, Columbia University (since August 1, formerly superintendent of schools, Baltimore, Maryland); Dr. John R. Heller, Director of the U. S. National Cancer Institute, Bethesda, Maryland; and Dr. Velma Linford, State Superintendent of Public Instruction, Cheyenne, Wyoming. There are still others, and dozens of our own colleagues in science teaching at all levels will as usual participate in panels, symposia, and discussions.

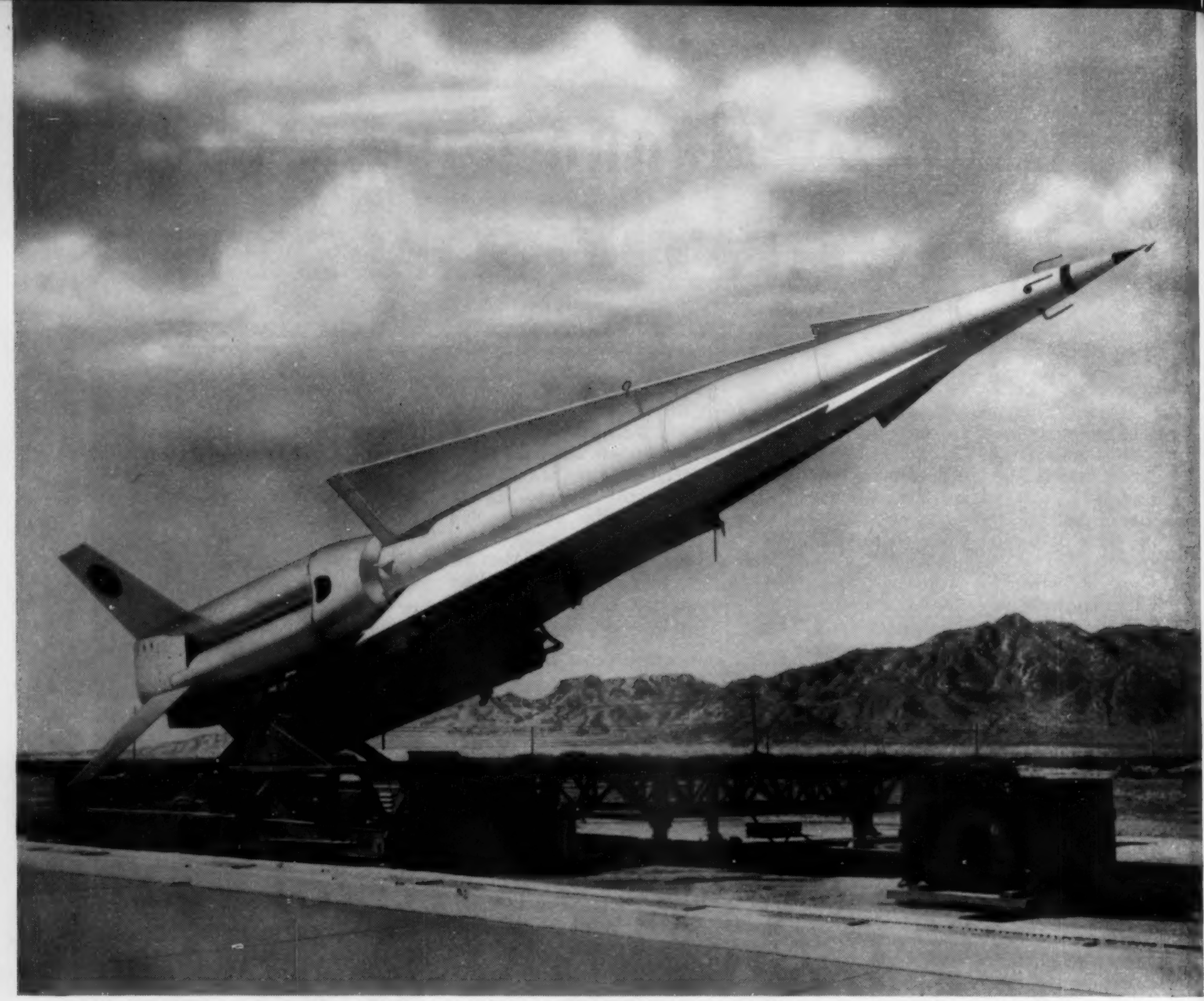
One of our agents reports that the convention committee is planning a "curriculum swap shop." They hope to have a large number of curriculum guides, courses of study, and syllabi on hand for examination—also to set up a plan so that you can trade in, say, two or three copies of your own curriculum guide and take others in exchange. (So if you don't have a K-12 curriculum guide, or even for K-1, better get busy and write one before next March 29.)

General sessions and the Exposition of Science Teaching Materials will be held in the beautiful Music Hall of the KC municipal convention center. Meal functions and many other sessions are scheduled in the Muehlebach and Phillips Hotels, designated as headquarters hotels for the convention.

Sessions for science supervisors, consultants, and coordinators will be conducted under NSTA sectional status for the first time. The group unanimously petitioned for this in Atlantic City, and approval was enthusiastically voted without dissent by the Board of Directors July 2 in St. Louis.

We have learned that a deep, dark plot is afoot to make registered attendance at KC the largest ever for NSTA. Denver holds the record (1863) with Atlantic City (1714) in second place. Given a decent break in the weather, KC registrations will hit 2500 (a guarantee, we're advised, by officers of adjacent state science teachers associations).

Plan now to be in Kansas City, March 29-April 2 (where "everything's up to date" and "they cain't say no"). Watch for the advance information and registration brochure; it will be mailed to reach you about January 2.



NSTA Activities

Secondary Science Conference

A national work-conference on selected problems of secondary school science (grades 7-12) will be held November 7-10 in Washington, D. C., by NSTA under a grant of $14,000 from the National Science Foundation. An invitational conference, some 40 representatives of classroom teachers, supervisors, principals and superintendents, college and university scientists, professors of education, and state education department personnel will face the issues and prepare a report. This will be aimed at providing guidance for the re-shaping of science courses and curricula, together with the provision of suitable personnel, facilities, and materials for instruction.

A sequel to the NSTA-NSF conference on elementary science held in May 1958, the secondary science conference is being planned by a Conference Committee under the chairmanship of Dr. Robert Stollberg, Professor of Science and Education, San Francisco State College.

Regional Meetings

Viewed briefly in chronological order, here is the schedule for 1959-60.

September 27-29: Tri-state (Maine, New Hampshire, Vermont) invitational conference on K-12 programs in science at Concord, N. H. Planning is under chairmanship of Mr. Frank W. Brown, Associate Director of Secondary School Services, State of New Hampshire Department of Education.

October 23-24: Sixth Annual Texas Conference for the Advancement of Science and Mathematics Teaching, Austin. NSTA is a co-sponsor and President Decker will address the conference.

November 27-28: New York City; regional, invitational conference on development of K-12 programs in science. Mr. Samuel Schenberg heads the planning committee.

December 26-30: Annual joint meeting of NSTA and other science teaching societies affiliated with the American Association for the Advancement of Science—the American Nature Study Society, Central Association of Science and Mathematics Teachers, National Association of Biology Teachers, and National Association for Research in Science Teaching; Hotel Sherman, Chicago, Illinois; open to all. More information will be given later.

March 29-April 2: Eighth Annual Convention of NSTA, Kansas City, Missouri.

April (tentative): Joint meeting in Canada of NSTA and Canadian science teachers.

July 1-2 (tentative): In Los Angeles, California; regular summer meeting of NSTA in conjunction with Annual Convention of NEA.

Board of Directors

At the helm of NSTA for 1959-60 are the following persons serving as Executive Committee (officers) and Regional Directors with terms expiring June 30 of the years in parentheses. These two groups together comprise the Board of Directors.

Executive Committee

President—Dr. Donald G. Decker, Colorado State College, Greeley (1960).

President-Elect—Mr. Robert A. Rice, Berkeley High School, Berkeley, California (1960; President 1960-61).

Retiring President—Dr. Herbert A. Smith, University of Kansas, Lawrence (1960). (Currently on leave to U. S. Office of Education.)

Secretary—Mrs. Sylvia Neivert, Bay Ridge High School, Brooklyn, New York (1960).

Treasurer—Mr. J. Donald Henderson, University of North Dakota, Grand Forks (1961).

Executive Secretary—Mr. Robert H. Carleton, 1201 Sixteenth Street, N. W., Washington 6, D. C.

Regional Directors

Region I—Mr. Frederick R. Avis, St. Marks School, Southborough, Massachusetts (1961).

Region II—Mr. C. Richard Snyder, Radnor High School, Wayne, Pennsylvania (1960).

Region III—Dr. Ruth E. Cornell, Wilmington Public Schools, Wilmington, Delaware (1961).

Region IV—Dr. Archie L. Lacey, Grambling State College, Louisiana (1960).

Region V—Dr. Albert Piltz, Detroit Public Schools, Michigan (1961).

Region VI—Dr. J. Hervey Shutts, Minneapolis Public Schools, Minnesota (1960).

Region VII—Dr. Horace H. Bliss, University of Oklahoma, Norman (1961).

Region VIII—Mr. Eugene Roberts, Polytechnic High School, San Francisco, California (1960).

FSA Activities

Program and Budget, 1959-60

According to plans for the year ahead—the eighth in FSAF history—students will be encouraged and recognized for superior achievement, teachers will be helped to do scientific research, a study will be made of teacher effectiveness, FSAF service booklets will be reprinted, certain on-going projects will be continued, and plans for a Future Scientists of America student program will be developed. Detailed items and budget projected for 1959-60 are:

1. Reprinting of booklets	$ 5,000.00
2. Continuing projects	6,500.00
3. On-the-Job Research	10,500.00
4. Teacher effectiveness study	500.00
5. FSA student activities	15,000.00
6. Committee and field services	2,500.00
7. Science Achievement Awards*	20,000.00
Sub-total	60,000.00
8. Administrative service charge	10,000.00
Total to be raised	$70,000.00

*Sponsored by the American Society for Metals

Administrative Committee, 1959-60

Activities and budget for NSTA's Future Scientists of America Foundation are developed by an Administrative Committee, which, after approval by the Board of Directors, then carries out the program. The group responsible for this year's program is as follows (terms end in year indicated).

Dr. Zachariah Subarsky, *Chairman*, Coordinator of Special Science Activities, Bronx High School of Science, New York City (1960).

Mr. Robert H. Carleton, Executive Secretary, NSTA, Washington, D. C.

Dr. Harold Cassidy, Associate Professor of Chemistry, Yale University, New Haven, Connecticut (1961).

Dr. Donald G. Decker, Dean of the College, Colorado State College, Greeley (1960).

Mr. J. Donald Henderson, Associate Professor of Physics, University of North Dakota, Grand Forks (1961).

Dr. Paul DeH. Hurd, Professor of Education, Stanford University, California (1962).

Dr. Philip G. Johnson, Chairman, Nature, Science, and Conservation Education, Cornell University, Ithaca, New York (1960).

Mr. Robert A. Rice, Head of Science Department, Berkeley High School, Berkeley, California (1961).

Miss Dorothy Tryon, Head of Science Department, Redford High School, Detroit, Michigan (1961).

Dr. Randall M. Whaley, Associate Dean, School of Science, Education, and Humanities, Purdue University, Lafayette, Indiana (1962).

Roster of Sponsors

It is indeed gratifying that even in the "lean months" of summer, contributions in support of FSAF have continued to come in. A total of $9,450 has been received since June 1, 1959. Listed below are the sponsors who have contributed in the past six months through July 22:

Allied Chemical Corporation
American Can Company
American Cyanamid Company
Armco Foundation
The Atlantic Refining Company
The Bristol-Myers Fund
The Bullard Company
Champion Spark Plug Company
Chrysler Corporation
The Dow Chemical Company
Fisher Foundation
The General Foods Fund, Inc.
P & H Harnischfeger Corporation
International Harvester Company
The International Nickel Company, Inc.
The Johnson Foundation
Kennecott Copper Corporation
Eli Lilly and Company
The Maytag Company Foundation
Monsanto Chemical Company
Owens-Illinois
The Procter & Gamble Fund
Raytheon Company
Rohm & Haas Company
Sheraton Corporation
Socony Mobil Oil Company, Inc.
Sprague Electric Company
Standard Oil Company (New Jersey)
Stauffer Chemical Company
West Virginia Pulp & Paper Company

Book Reviews

Darwin and the Darwinian Revolution. Gertrude Himmelfarb. 480p. $5.95. Doubleday and Co., Inc., 575 Madison Ave., New York 22, N. Y. 1959.

In this hundredth anniversary year of the publication of the *Origin of Species,* it is most appropriate that Dr. Himmelfarb's research on Darwin and Darwinism be published in this extremely readable book. Throughout the book she explores scores of misconceptions concerning Darwin, his predecessors and his contemporaries. All too often we picture our heroes of the past as unerring men without human frailties. Such is the case of Charles Darwin. Without detracting from the greatness of Darwin's contribution to science, the author sets the record straight regarding the influence of his grandfather, the role of his father, his associations with contemporaries, his voyage on the *Beagle,* the events surrounding the publication of the *Origin,* and the subsequent controversy.

The documentation in this book is remarkably complete with over a thousand citations, many from Darwin's personal correspondence. The book itself is organized into six "books" with these titles: Pre-history of the Hero, Emergence of the Hero, Emergence of the Theory, Reception of the *Origin,* Analysis of the Theory, and Darwinism. This brilliantly written book deserves wide circulation. Biology teachers especially will find it of interest.

Harvey A. Feyerherm
Northern Illinois University
DeKalb, Illinois

Science and Education at the Crossroads: A View from the Laboratory. Joseph W. Still. 140p. $3.75. Public Affairs Press, 419 New Jersey Ave., S.E., Washington 3, D. C. 1958.

This volume, by a medical man who is also a thoughtful research worker, administrator, and statesman, takes the view that a rational application of scientific principles, and of the life sciences, may yet save civilization and mankind. The book is in two main parts. The first section is concerned primarily with the problems of the teaching of the sciences in the U. S. The second section is concerned with the use of the biological sciences to meet the underlying problems of international friction.

In the first part we are faced with the wondrous circumstances of our educational system, which seems to try to get something for nothing, and gets what it pays for. We are confronted with the Russian example in education, and then are presented with some proposals for correcting our deficiencies without copying the system we feel we are competing with. Dr. Still points out the futility involved in the search for the "gifted," as well as in trying to "produce" scientists. He notes that the inclination to be a scientist is difficult to nurture, and especially so when our culture makes it clear that a scientist is hardly a citizen. That the Soviets are successful in nurturing the scientific inclination can no longer be ignored.

In the second part of the book Dr. Still effectively shows that much of the unrest in the "underdeveloped" parts of the world is: (1) Of strictly biological origin; (2) Largely of our own doing; and (3) Subject to useful and peaceful direction and solution; if we (4) Use the biological scientist and education as a political tool. Even for those who can only react to arguments based on personal survival the struggle to "develop" rapidly the "underdeveloped" should be paramount. "The prize of success will be world peace. The penalty for failure may be world death. We have no choice but to accept the challenge. To debate 'whether' under these conditions is absurd."

The principles and thoughts outlined in this book will seem easy to the science teacher, but they are not obvious. An understanding of them should be required of every science teacher, because it is only through the students we teach that a rational approach to our world can arise.

Jack Bennett
Northern Illinois University
DeKalb, Illinois

Soviet Space Science, The Russian Story of Artificial Satellites. Ari Shternfeld. 361p. $6. Basic Books, Inc., 59 Fourth Ave., New York 3, N. Y. 1959.

This book is an excellent survey of astronautics. The translation from the Russian version is done without loss of scientific meaning. The psychological approaches to scientific findings in the science of astronautics are features of this book which hold the scientific reader. The ideas presented are clearly stated and systematically organized. The usual confusion of terminology seems to be absent from this report.

The book contains a comprehensive survey of the experiments and researches being conducted in the various countries of the world in the field of astronautics. The author seems to have as accurate a knowledge of American work in this scientific field as he has of the accomplishments of the Russian scientists. Since much of the data relative to the Russian accomplishments in astronautics has not been translated into English, this book gives the American scientist an opportunity to become familiar with Russian scientific work in the field.

The chapters in the book deal with such topics as the laws of motion demonstrated by artificial satellites, satellite orbits and their geometry, kinds of rocket engines, launching technics, construction of satellites, man's problems in space to be anticipated, possible space ship problems, problems of communications from space to earth, return to earth procedures, return to space problems, trips to the moon procedures, and finally, possible uses of space ships in science research.

Loren T. Caldwell
Northern Illinois University
DeKalb, Illinois

SCIENCE TEACHING MATERIALS

Prepared by NSTA Teaching Materials Review Committee
Dr. Robert A. Bullington, Chairman
Northern Illinois University, Dekalb

BOOK BRIEFS

THE PERSPECTIVE UNIVERSE. James P. Calk. 67p. $2.75. Exposition Press, Inc., 386 Fourth Ave., New York 16, N. Y. 1959.

Statement of the author's hypothesis of the geophysical origin and nature of our galaxy, our solar system, our sun, and our earth. It is an interesting book since it challenges the reader to agree or disagree with the author's explanations. A reference book for the lay student of geophysics. Its accuracy cannot be determined at this present state of factual data in the field of geophysical literature.

OUR EARTH. Arthur Beiser. 123p. $2.95. E. P. Dutton & Company, 300 Fourth Ave., New York 10, N. Y. 1959.

Gives the latest information about the size of the earth, its position in the solar system, its composition and surface, and its atmosphere and magnetic field. Concludes with the latest theory for the origin of the earth and its possible life history. This book gives indication of having great authenticity. A good reader for all students of the earth sciences.

FIND A CAREER IN ELECTRONICS. Wallace West. 158p. $2.75. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

Gives reader an exploratory overview of the field of electronics and its vocational opportunities. Explains needed aptitudes, essential high school courses, college requirements, and other guidance aids. Also contains some interesting electronics projects. Illustrated with photographs. Suitable for junior and senior high.

DARWIN, WALLACE, AND THE THEORY OF NATURAL SELECTION. Bert James Loewenberg. 97p. $5. 1959. Published by Arlington Books and distributed by Taplinger Publishing Co., Inc., 119 W. 57th St., New York 19, N. Y.

An exciting account of the relationship of Wallace and Darwin in developing the Theory of Natural Selection. To quote the author, "Wallace helped Darwin to become the man he really was." Included are the two pertinent papers read at the Linnean Society.

FUNDAMENTALS OF NUCLEAR ENERGY AND POWER REACTORS. Henry Jacobowitz. 144p. $2.95. John F. Rider Publisher, Inc., 116 West 14th St., New York 11, N. Y. 1959.

The book discusses qualitatively the elementary concepts of nuclear physics. Fission process and chain reactions are explained in order to acquaint the reader with the mechanism of the release of nuclear energy and its control for peaceful uses. Nuclear reactors, their operation and uses are clearly explained. Simple, up-to-date, and well illustrated through pictorial representation. Very useful by those who wish to have an understanding of the advances in applied nuclear physics.

THE MOON. George Gamow. 120p. $2.75. Abelard-Schuman, Inc., 404 Fourth Ave., New York 16, N. Y. 1959.

Contains the most recent data known about the moon. Explains clearly the moon's orbit, gravitation, eclipses, origin, chemical composition, atmosphere, and terrain. The history of the moon and the moon rocket presented in understandable terms. Many illustrations and actual photographs included. Revision of the 1953 edition. Easily read by junior high and senior high school students.

NSTA Teaching Materials Review Committee

Reviews and reports on teaching materials used in elementary and secondary school science programs will be continued in this series. NSTA and Northern Illinois University are cooperating in this joint project and the committee will be chaired by Dr. Robert A. Bullington. Suppliers and publishers are requested to send duplicate copies directly to Dr. Bullington of any teaching materials or books sent to NSTA.

The full roster of committee members will appear in a later issue of TST.

WHY YOU ARE YOU. Amram Scheinfeld. 171p. $3.50. Abelard-Schuman, Inc., 404 Fourth Avenue, New York 16, N. Y. 1958.

This book is subtitled "The true adventure story of how you came to look, think and act as you do," and is appropriate for children of 8 to 12 years. It is the excellent quality of Scheinfeld's other books on human biology and heredity, but is specifically adapted to children. As a geneticist the reviewer would take issue with some of the illustrations and similies *if* the book were intended for high school or older readers. It should be a tremendous boon to parents who are perplexed at how to effectively answer a child's questions about his origin and individuality.

The facts of gamete production, fertilization, and development are handled gracefully and on the child's terms. The reasons behind human differences, sexual, hereditary, and environmental, are explained in an honest and reasonable way. New words are carefully explained and pronounced, so that no third grader should experience undue difficulty reading the book.

LIFE GOES ON. Second Edition. R. Will Burnett, Jessie Williams Clemensen, and Howard S. Hoyman. 56p. 96¢. Harcourt, Brace and Co., Inc., 750 Third Ave., New York 17, N. Y. 1959.

A separate booklet on sex education to supplement standard biology texts. Covers basic anatomy and physiology of the human reproductive system, principles of heredity, pre-natal and post-natal development, growing up, and marriage. Valuable resource for high school.

BOMBER PLANES THAT MADE HISTORY. David C. Cooke. 72p. $2.50. G. P. Putnam's Sons, 210 Madison Ave., New York 16, N. Y. 1959.

Gives the development of the bomber plane between 1912 and 1958. Suitable for the aviation-minded junior high student. Interestingly written and well illustrated.

MILLIONS OF YEARS AGO. Edwin H. Colbert. 150p. $2.75. Thomas Y. Crowell Co., 432 Fourth Ave., New York 16, N. Y. 1958.

Takes the reader into world of prehistoric life. The work and equipment of paleontologist described. Shows how interpretation of fossils by paleontologist leads to understanding of emergence of life forms. Development of earth, climates, and man described. Illustrated with drawings. Indexed. Excellent for middle grades and junior high.

CHANGING THE FACE OF NORTH AMERICA. Patricia Lauber. 94p. $2.50. Coward-McCann, Inc., 210 Madison Ave., New York 16, N. Y. 1959.

Gives an appreciation of the magnitude of the St. Lawrence Seaway. Historical survey treats the work of explorers and traders along the early water routes, and the vision the French had of the significance of the Great Lakes and St. Lawrence. The growth and development of the waterway, the natural resources of the Great Lakes region, the advantage of cheap bulk water transport, and the new seaports which the seaway will create are described in a style interesting to the middle grade and junior high student. Illustrated photographs and maps.

A Zoo of My Own. Cornelius Conyn. 192p. $3. The John Day Company, 210 Madison Ave., New York 16, N. Y. 1958.

Gives information about unfamiliar mammals, birds, and reptiles. Contains accurate and interesting data in a story form. Enjoyable reading material for the junior high school age.

Careers and Opportunities in Engineering. Phillip Pollack. 140p. $3.50. E. P. Dutton and Co., 300 Fourth Ave., New York 10, N. Y. 1959.

Lists personal and professional qualifications. Describes various branches of engineering. Points out opportunities for women in engineering. Lists educational institutions accredited by Engineers Joint Council. Should be useful to vocational counselors and to students interested in engineering.

PROFESSIONAL READING

"The Climate of Invention." By George R. Price. *Think*, June 1959. Points out the need of the inventor by industry and defense and for living in this modern era; examines two opposing views of the inventive process in America as negative factors in our progress.

"Creators of Environment." By Myron A. Coler. *Teaching and Learning*. Journal of the Ethical Culture Schools of New York City, N. Y. 1959. The author reviews the creative approach to learning as a means for students to absorb the rapidly increasing body of knowledge, especially in the sciences. Environment, and people, and teachers especially, are the important influences.

"The Cooperative Approach to Audio-Visual Programs." Department of Audio-Visual Instruction and Department of Rural Education, National Education Association, Washington, D. C. Report on a research project of DAVI's Committee on County Cooperative Programs. Instructional Materials, Cooperative Centers, Staff and Center Financing; and Recommendations for programs are covered.

"Extra-terrestrial Geology." By Robert W. Greenwood. *Geotimes*, 3:8. January-February 1959. A long-range time table for extra-terrestrial research starting with those which will be earthbound and extending to those in which the earth is to be merely the take-off point.

"The Superintendent's Viewpoint on Educational Television." By The Thomas Alva Edison Foundation, New York. March 1959. This 28-page publication covers a panel discussion before the Region I Conference of the National Association of Educational Broadcasters in New York on September 20, 1958. Participants were from Hagerstown, Md., Newton, Mass., Philadelphia, Pa., and New York City, N. Y.

"Closed-Circuit Television." By the Board of Education, Hagerstown, Md. March 1959. A 50-page progress report on teaching in Washington County, 1958 through 1959.

AUDIO-VISUAL AIDS

DEPENDENT PLANTS GROUP. Designed for use with the Unitext *Dependent Plants* in publisher's Basic Science Education Series. Accompanied by very complete *Teacher's Manual* by Bertha M. Parker. For use in upper elementary and high school science. Pictures and manual show kinds of dependent plants—bacteria, yeasts, molds, mushrooms, and their place in nature. Interrelationships are stressed. Brief coverage of life cycles and methods of reproduction. Similarity of edible and non-edible mushrooms is stressed. Filmstrips: *Dependent Plants,* 44 frames; *Mushrooms,* 45 frames. Color, Set with guide, $10.80. 1958. Row, Peterson and Co., 1911 Ridge Ave., Evanston, Ill., and Society for Visual Education, Inc., 1345 W. Diversey Parkway, Chicago 14, Ill.

LAWS OF CONSERVATION OF ENERGY AND MATTER. Simple laboratory experiments introduce and clarify the concept that matter and energy may not be created or destroyed. A well-defined explanation of Einstein's equation that matter and energy can be converted into one another is a fine feature of this film. Suitable for junior and senior high school. 8 min. Color $82.50, B&W $45. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

OUR SENSES: WHAT THEY DO FOR US. This film presents the function and importance of the five senses of the body. Cutaway views, animation, and live photography are employed to illustrate functions. Aids for defective sight and hearing are portrayed. Emphasizes care and appreciation of sense organs. Very suitable for elementary grades. 11 min. Color $110, B&W $60. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

THE HUMAN BODY: NERVOUS SYSTEM. Recommended for high school biology, advanced junior high or beginning college courses in which students have minimal science background. Film is built around reflex arc and includes consideration of other aspects of the nervous system. Animation is good and technical terminology is held to minimum. This simplified presentation of the nervous system would furnish a good introduction to the subject. 14 min. Color $137.50, B.&W. $75. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

BEYOND THE SOLAR SYSTEM. For intermediate and upper grades. Discusses the polar constellations, apparent motion of stars, star size, distance, and temperature. Includes pictures of nebulae and description of the universe. Authentic pictures from Yerkes Observatory, Wisconsin. Well narrated. 9 min. B.&W. $60. 1958. Coronet Films, Coronet Building, Chicago 1, Ill.

APPARATUS AND EQUIPMENT

SCIENCE TOY COLLECTION KITS. These toy kits contain self-directing activities and numerous toys to illustrate basic concepts of science. The toys for the most part are durable and satisfactorily meet health requirements for classroom use. Pointed questions are found in the accompanying manuals with many excellent illustrations to demonstrate the experiments to be performed and science concepts being illustrated. Each from $1.50 to $4.

The Color Top incorporates many science concepts. Wheels of color blend together to form various hues, and musical reeds change pitch with speed. $2.

The Spectroscope Kit is an excellent visual teaching aid for upper elementary and junior high children. Students using this spectroscope have the experience of the "exploratory approach to learning." Seventeen possible experiments have been provided from simplicity of seeing "colors in the spectrum" to more difficult "calculating the frequency of light." $2. Science Materials Center, 59 Fourth Ave., New York 3, N. Y.

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